MERCURY
MerCruiser

SERVICE MANUAL

Supplement to Number 24

MARINE ENGINES

GM V-8
377 CID (6.2L)

Printed in U.S.A.
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90-861327000 700

Notice

Throughout this publication, “Dangers,” “Warnings” and “Cautions” (accompanied by the International HAZARD Symbol ⚠) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. **OBSERVE THEM CAREFULLY!**

These “Safety Alerts” alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus “Common Sense” operation, are major accident prevention measures.

⚠ DANGER

DANGER - Immediate hazards which WILL result in severe personal injury or death.

⚠ WARNING

WARNING - Hazards or unsafe practices which COULD result in severe personal injury or death.

⚠ CAUTION

Hazards or unsafe practices which could result in minor personal injury or product or property damage.

Notice to Users of This Manual

This service manual has been written and published by the Service Department of Mercury Marine to aid our dealers’ mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine, that they have been trained in the recommended servicing procedures of these products which includes the use of mechanics’ common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the products safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

It should be kept in mind, while working on the product, that the electrical system and ignition system are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note, during any maintenance procedure replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for reuse in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

We reserve the right to make changes to this manual without prior notification.

Refer to dealer service bulletins for other pertinent information concerning the products described in this manual.

Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation and, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts, will void the warranty on those parts which are damaged as a result of the use of other than recommended replacement parts.

Replacement Parts

⚠ WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Sterndrives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Models Covered In This Manual

Sterndrive (MCM) Model	Serial Number
MX 6.2 MPI	0L680003 and Above

Inboard (MIE) Model	Serial Number
MX 6.2 MPI	0L680003 and Above

Ski Model	Serial Number
MX 6.2 Black Scorpion	0L680003 and Above

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Service Manual Supplement Outline

Section 1 - Important Information

A - General Information

B - Maintenance

Section 3 - Engine

A - 377 CID / 6.2L Engines

Section 4 - Electrical Systems

E - Wiring Diagrams

Section 5 - Fuel Systems

E - Fuel Injection System Assembly and Disassembly

G - Diagnostics

Table of Contents

IMPORTANT INFORMATION

Section 1A - General Information

General Information 1A-3

Section 1B - Maintenance

Tools 1B-2
Lubricants / Sealants / Adhesives 1B-2
Maintenance Schedules 1B-3
Maintenance Intervals 1B-3
Gas Sterndrive 1B-3
Routine Maintenance * 1B-3
Scheduled Maintenance * 1B-4
Gas Inboard 1B-5
Routine Maintenance * 1B-5
Scheduled Maintenance * 1B-6
Engine and Tune-Up Specifications 1B-7
MCM (Sterndrive) 1B-7
MIE (Inboard) 1B-8
Ski 1B-9
Fluid Capacities 1B-10
Engines 1B-10
Sterndrives 1B-10
Transmissions 1B-11
20-Hour Break-In Period 1B-11
After Break-in Period 1B-12
End of First Season Checkup 1B-12
Specifications 1B-12
Fuel Recommendations 1B-12
Test For Alcohol Content In Gasoline . 1B-15
Transmission Fluid 1B-15
Power Steering Fluid 1B-15
Coolant for Closed Cooling System 1B-15
Crankcase Oil 1B-16
Overfilled Crankcase Oil 1B-16
Checking Engine Oil Level / Filling ... 1B-17
Changing Oil and Filter 1B-17
Changing Water Separating Fuel Filter .. 1B-18
MCM (Sterndrive) Models 1B-19
Power Steering System 1B-20
Checking Fluid Level 1B-20
Engine Cold 1B-20
Filling and Bleeding 1B-21
Closed Cooling System 1B-22
Checking Coolant Level 1B-22
Flushing System MCM (Sterndrive) .. 1B-23
Flushing System MIE (Inboard and Ski) 1B-25
Transmission Fluid 1B-26
Lubrication 1B-27
Throttle Cable 1B-27
Shift Cable and Transmission Linkage 1B-27
Engine Coupler/U-Joint Shaft Splines 1B-29
Sterndrive Drive Shaft Extension Models 1B-30
Starter Motor 1B-30
Cleaning Flame Arrestor 1B-31
Black Scorpion Flame Arrestor 1B-32
Serpentine Drive Belt 1B-32
Component Location 1B-32
Inspection 1B-34
Replacing and/or Adjusting Tension .. 1B-34
Ignition Timing 1B-35
EFI/MPI Models 1B-35
Cold Weather or Extended Storage 1B-36
Precautions 1B-36
Power Package Layup 1B-37
Draining Instructions 1B-39
Draining Sterndrive Unit 1B-43
Recommissioning 1B-44

ENGINE

Section 3A - 377 cid (6.2L) Engines

Torque Specifications 3A-3
Special Tools 3A-5
Specifications 3A-6
General Specifications 3A-6
Engine Specifications 3A-7
General Information 3A-11
Repair Procedures 3A-11
Engine Identification 3A-11
Engine Rotation 3A-12
Description 3A-12
Crankshaft 3A-12
Piston and Connecting Rods 3A-12
Camshaft and Drive 3A-12
Cylinder Head 3A-13
Valve Train 3A-13
Intake Manifold 3A-13
Lubrication System 3A-13
Bearing Failures 3A-14
Piston Failures 3A-16
Pre-Ignition 3A-16
Detonation 3A-17
Engine Mounts 3A-18
Engine Mounts (Continued) 3A-19
Rocker Arm Cover 3A-20
Removal 3A-20
Installation 3A-20
Intake Manifold 3A-21
Removal 3A-21
Cleaning and Inspection 3A-21
Installation 3A-22
Rocker Arm / Push Rod 3A-23
Removal 3A-23
Cleaning and Inspection 3A-23
Installation 3A-23
Valve Adjustment 3A-24
Engine Stopped 3A-24
Engine Operating 3A-25
Hydraulic Valve Lifters 3A-26
Locating Noisy Lifters 3A-26
Removal 3A-27
Cleaning and Inspection 3A-28
Installation 3A-28
Valve Stem Oil Seal / Valve Spring 3A-29
Removal - Head Installed 3A-29
Valve Assembly (Exploded View) 3A-30
Installation - Head Installed 3A-30
Cylinder Head 3A-31
Removal 3A-31
Cleaning and Inspection 3A-32
Installation 3A-32
Cylinder Head and Valve Conditioning . . 3A-33
Disassembly 3A-33
Cleaning and Inspection 3A-34
Valve Guide Bore Repair 3A-36
Valve Springs - Checking Tension 3A-36
Rocker Arm Stud Replacement 3A-37
Valve Seat Repair 3A-38
Valve Grinding 3A-39
Reassembly 3A-40
Crankcase Oil Dipstick Specifications . . . 3A-43
Oil Pan 3A-44
Removal 3A-44
Cleaning and Inspection 3A-44
Installation 3A-44
Oil Pump 3A-47
Exploded View 3A-47
Removal 3A-48
Disassembly 3A-49
Cleaning and Inspection 3A-49
Reassembly 3A-49
Installation 3A-50
Torsional Damper 3A-50
Removal 3A-50
Installation 3A-51
Crankcase Front Cover Oil Seal 3A-52
Oil Seal Replacement
(Without Removing Front Cover) 3A-52
Crankcase Front Cover 3A-53
Removal 3A-53
Cleaning and Inspection 3A-53
Installation 3A-53
Flywheel 3A-55
Removal 3A-55
Cleaning and Inspection 3A-55
Installation 3A-56
Rear Main Oil Seal 3A-57
Removal 3A-57
Cleaning and Inspection 3A-57
Installation 3A-57
Rear Main Oil Seal Retainer 3A-59
Removal 3A-59
Cleaning and Inspection 3A-59
Installation 3A-59
Main Bearings 3A-60
Inspection 3A-60
Checking Clearances 3A-60
Replacement 3A-62
Connecting Rod Bearings 3A-64
Inspection and Replacement 3A-64

Section 3A - 377 cid (6.2L) Engines (Continued)

Connecting Rod / Piston Assembly 3A-66
Removal 3A-66
Disassembly 3A-67
Cleaning and Inspection 3A-68
Reassembly 3A-69
Installation 3A-71
Crankshaft 3A-73
Removal 3A-73
Cleaning and Inspection 3A-76
Installation 3A-76
Timing Chain and Sprocket 3A-77
Removal 3A-77
Cleaning and Inspection 3A-78
Crankshaft Sprocket/Gear 3A-78
Removal 3A-78
Installation 3A-78
Checking Timing Chain Deflection ... 3A-79
Camshaft 3A-79
Measuring Lobe Lift 3A-79
Removal 3A-80
Inspection 3A-80
Installation 3A-81
Camshaft Bearings 3A-81
Removal 3A-81
Cleaning and Inspection 3A-82
Installation 3A-82
Cylinder Block 3A-83
Cleaning and Inspection 3A-83
Oil Filter By-Pass Valve and Adaptor Assembly 3A-87
Removal 3A-88
Cleaning and Inspection 3A-88
Installation 3A-88

Section 4E - Wiring Diagrams

Starting and Charging Harness 4E-2
MCM MX 6.2L MPI Engines 4E-2
MIE MX 6.2 MPI and MX 6.2 Black Scorpion Engines - 4E-4
Fuel and Ignition System Harness 4E-6
MX 6.2 MPI and MX 6.2 Black Scorpion Engines 4E-6

FUEL SYSTEM

Section 5E - Fuel Injection Disassembly And Reassembly

Service Precautions 5E-2
Specifications 5E-3
Torque Specifications 5E-3
Lubricants / Sealants / Adhesives 5E-3
Sensor Voltage 5E-3
Exploded Views - MX 6.2L MPI 5E-4
Flame Arrestor And Throttle Body 5E-4
Intake Manifold And Fuel Rail 5E-5
Fuel Pressure Relief Procedure 5E-6
MX 6.2 MPI Components 5E-6
Flame Arrestor 5E-6
Throttle Body 5E-8
Throttle Position Sensor 5E-11
Idle Air Control (IAC) Valve 5E-13
Knock Sensor 5E-15
Knock Sensor Module 5E-16
Fuel Pump Relay 5E-16
System Relay 5E-17
Electronic Control Module (ECM) 5E-17
Engine Coolant Temperature (ECT) Sensor 5E-18
Vacuum And Vent Hose Routing 5E-19
MX 6.2 MPI Models 5E-19
Exploded Views - MX 6.2 Black Scorpion 5E-20
Plenum, Throttle Body And Flame Arrestor 5E-20
Intake Manifold And Fuel Rails 5E-21
Fuel Pressure Relief Procedure 5E-22
MX 6.2 Black Scorpion Components 5E-22
Flame Arrestor 5E-22
Throttle Body 5E-24
Plenum 5E-28
Fuel Rails 5E-30
Fuel Injectors 5E-32
MAP Sensor 5E-33
Throttle Position Sensor 5E-34
Idle Air Control (IAC) Valve 5E-35
Knock Sensor 5E-37
Knock Sensor Module 5E-38
Fuel Pump Relay 5E-39
System Relay 5E-39
Engine Control Module 5E-40
Engine Coolant Temperature Sensor . 5E-41
Vacuum And Vent Hose Routing 5E-42
MX 6.2 Black Scorpion Models 5E-42

Section 5G - Diagnostics

Special Tools 5G-2
Special Tools (cont'd) 5G-3
Diagnostic Circuit Check 5G-4
Scan Tool Normal Specifications (Idle/Warm Engine/Closed Throttle/Neutral) 5G-4
Diagnostic Trouble Codes 5G-5
ECM Connector and EFI Symptoms Chart 5G-6
J-1 Circuits 5G-7
J-1 Circuits (Continued) 5G-8
J-2 Circuits 5G-9
J-2 Circuits(Continued) 5G-10
Wiring System Diagrams 5G-11
(Continued) 5G-12
With Mercury Distributor 5G-13
With GM EST Distributor 5G-14

IMPORTANT INFORMATION

Section 1A - General Information

1 A

Table of Contents

General Information 1A-3

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INDEX

General Information

The following sections of supplemental information to SERVICE MANUAL NUMBER 24 have been prepared to assist in the identification and servicing of 6.2L / 377 CID MerCruiser engines.

Therefore, this supplement is intended to be used in conjunction with SERVICE MANUAL NUMBER 24 and not in place of the manual. The scope of this supplement is to highlight new or different specifications, components and procedural information as they pertain to the 6.2L / 377 CID engines versus the 5.7L / 350 CID engines.

INDEX

IMPORTANT INFORMATION

Section 1B - Maintenance

1 B

Table of Contents

Tools 1B-2
Lubricants / Sealants / Adhesives 1B-2
Maintenance Schedules 1B-3
  Maintenance Intervals 1B-3
Gas Sterndrive 1B-3
  Routine Maintenance * 1B-3
  Scheduled Maintenance * 1B-4
Gas Inboard 1B-5
  Routine Maintenance * 1B-5
  Scheduled Maintenance * 1B-6
Engine and Tune-Up Specifications 1B-7
  MCM (Sterndrive) 1B-7
  MIE (Inboard) 1B-8
  Ski 1B-9
Fluid Capacities 1B-10
  Engines 1B-10
  Sterndrives 1B-10
  Transmissions 1B-11
20-Hour Break-In Period 1B-11
After Break-in Period 1B-12
End of First Season Checkup 1B-12
Specifications 1B-12
  Fuel Recommendations 1B-12
  Test For Alcohol Content In Gasoline . 1B-15
Transmission Fluid 1B-15
Power Steering Fluid 1B-15
Coolant for Closed Cooling System 1B-15
Crankcase Oil 1B-16
  Overfilled Crankcase Oil 1B-16
  Checking Engine Oil Level / Filling . . . 1B-17
Changing Oil and Filter 1B-17
Changing Water Separating Fuel Filter . . 1B-18
  MCM (Sterndrive) Models 1B-19
Power Steering System 1B-20
  Checking Fluid Level 1B-20
  Engine Cold 1B-20
  Filling and Bleeding 1B-21
Closed Cooling System 1B-22
  Checking Coolant Level 1B-22
  Flushing System MCM (Sterndrive) . . 1B-23
  Flushing System MIE
  (Inboard and Ski) 1B-25
Transmission Fluid 1B-26
Lubrication 1B-27
  Throttle Cable 1B-27
  Shift Cable and Transmission Linkage 1B-27
  Engine Coupler/U-Joint Shaft Splines 1B-29
  Sterndrive Drive Shaft Extension
  Models 1B-30
  Starter Motor 1B-30
Cleaning Flame Arrestor 1B-31
  Black Scorpion Flame Arrestor 1B-32
Serpentine Drive Belt 1B-32
  Component Location 1B-32
  Inspection 1B-34
  Replacing and/or Adjusting Tension . . 1B-34
Ignition Timing 1B-35
  EFI/MPI Models 1B-35
Cold Weather or Extended Storage 1B-36
  Precautions 1B-36
  Power Package Layup 1B-37
  Draining Instructions 1B-39
  Draining Sterndrive Unit 1B-43
  Recommissioning 1B-44

INDEX

Tools

Description	Part Number
Timing Light	91-99379
Quicksilver Scan Tool	91-823686A2

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Loctite Pipe Sealant With Teflon	Obtain Locally
Quicksilver U-Joint and Gimbal Bearing Grease	92-828052A2

Maintenance Schedules

Maintenance Intervals

Maintenance intervals and the tasks to be performed are generally based on an average boating application and environment. Individual operating habits and personal maintenance preferences can have an impact on the suggested intervals. In consideration of these factors, Mercury MerCruiser has adjusted some maintenance intervals and corresponding tasks to be performed. This may allow for more individual tasks to be performed in a single visit to the serving dealer, rather than multiple visits. Therefore, the boat owner and servicing dealer should discuss the current Maintenance Schedule and develop appropriate maintenance intervals to coincide with the individual operating habits, environment and maintenance requirements.

Always disconnect battery cables from battery BEFORE working around electrical components to prevent injury to yourself and damage to electrical system should a wire be accidentally shorted.

Gas Sterndrive

Routine Maintenance *	Each Day Start	Each Day End	Weekly	Every Two Months
Check crankcase oil (interval can be extended based on experience).	●			
If operating in salt, brackish or polluted waters, flush cooling system after each use.		●		
Check drive unit oil level, trim pump oil level and power steering pump fluid level.			●	
Check water pickups for debris or marine growth. Check water strainer and clean. Check coolant level.			●	
Inspect drive unit anodes and replace if 50 percent eroded.			●	
Check battery connections and fluid level.				●
Lubricate propeller shaft and the retorque nut (if operating only in freshwater, this maintenance may be extended to every four months).				●
Operating in Saltwater Only: treat engine surface with corrosion guard.				●

* Only perform maintenance that applies to your particular power package

● Standard Models

INDEX

Gas Sterndrive(Continued)

Scheduled Maintenance *

	Annually	Every 100 hours or Annually	Every 200 hours or 3 years	Every 300 hours or 3 years	Every 2 years	Every 5 years
Touch-up paint power package and spray with Corrosion Guard.	●					
Change crankcase oil and filter.		●				
Change drive unit oil and retorque connection of gimbal ring to steering shaft.		●				
Replace fuel filter(s).		●				
Check steering system and remote control for loose, missing or damaged parts. Lubricate cables and linkages.		●				
Inspect U-joints, splines and bellows. Check clamps. Check engine alignment. Lubricate U-joints splines.		●				
Lubricate gimbal bearing and engine coupler.		●8				
Check continuity circuit for loose or damaged connections. Test MerCathode® unit output on Bravo Models.		●				
Retorque engine mounts.		●				
Check spark plugs, wires, distributor cap and ignition timing. Check and adjust idle speed.		●				
Clean flame arrestor and crankcase ventilation hoses. Replace PCV valve.		●				
Check electrical system for loose, damaged or corroded fasteners.		●				
Inspect condition and tension of belts.		●				
Check cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks.		●				
Disassemble and inspect seawater pump and replace worn components.		●				
Clean seawater section of closed cooling system. Clean, inspect and test pressure cap.		●				
Replace coolant.					♠	●

* Only perform maintenance that applies to your particular power package

● Standard Models

★ Horizon Models

◆ Whichever Occurs First

♠ Interval will be reduced if not using extended life coolant.

8 Lubricate engine coupler every 50 hours if operated at idle for prolonged periods of time.

INDEX

Gas Inboard

Routine Maintenance *	Each Day Start	Each Day End	Weekly	Every Two Months
Check crankcase oil (interval can be extended based on experience).	●			
If operating in salt, brackish or polluted waters, flush cooling system after each use.		●		
Check transmission fluid.			●	
Check water pickups for debris or marine growth. Check water strainer and clean. Check coolant level.			●	

* Only perform maintenance that applies to your particular power package

● Standard Models

★ Horizon Models

INDEX

Gas Inboard(Continued)

Scheduled Maintenance *	Annu-ally	Every 100 hours or Annually ◆	Every 200 hours or 3 years ◆	Every 300 hours or 3 years ◆	Every 2 years	Every 5 years	Per OEM
Touch-up paint power package and spray with corrosion guard.	●★						
Change crankcase oil and filter.		●★					
Change transmission fluid.		●★					
Replace fuel filter(s).		●★					
Check steering system and remote control for loose, missing or damaged parts. Lubricate cables and linkages.		●★					
Retorque engine mounts.		●		★			
Check spark plugs, wires, distributor cap and ignition timing. Check and adjust idle speed.		●		★			
Clean flame arrestor and crankcase ventilation hoses. Replace PCV valve.		●		★			
Check electrical system for loose, damaged or corroded fasteners.		●		★			
Inspect condition and tension of belts.		●		★			
Check cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks.		●		★			
Disassemble and inspect seawater pump and replace worn components.		●		★			
Clean seawater section of closed cooling system. Clean, inspect and test pressure cap.		●		★			
Replace coolant.					●	★♠	
Check engine-to-propeller shaft alignment.							●★

* Only perform maintenance that applies to your particular power package

● Standard Models

★ Horizon Models

◆ Whichever Occurs First

♠ Interval will be reduced if not using extended life coolant.

INDEX

Engine and Tune-Up Specifications

MCM (Sterndrive)

Model	MX 6.2 MPI
Propshaft Horsepower (SAV1 Rating)	320[1]
Propshaft Kilowatts (SAV1 Rating)	239[1]
Number of Cylinders	V-8
Displacement	377 cid (6.2 l)
Bore / Stroke - in. (mm)	4.00 x 3.75 (101.6 x 95.25)
Compression Ratio	9.0:1
Compression Pressure	Minimum 100 psi (690 kPa)[5]
Idle rpm In Neutral[4]	600 rpm[6]
Maximum rpm (at WOT)[2]	4800-5200 rpm
Oil Pressure (at 2000 rpm)	Minimum 30 psi (207 kPa)
Minimum Oil Pressure (at Idle)	Minimum 4 psi (28 kPa)
Fuel Pressure (1800 rpm)	30 psi (207 kPa)
Electrical System	12 V Negative (–) Ground
Alternator Rating – Cold Operating Amps	72 Amp
Alternator Rating – Hot Operating Amps	65 Amp
Minimum Battery Requirements	550 cca / 700 mca / 120 Ah
Firing Order	1-8-4-3-6-5-7-2
Spark Plug Type	AC - MR43LTS Champion - RS12YC NGK - BPR6EFS
Spark Plug Gap	.045 in. (1.1 mm)
Timing (at idle rpm)[3]	8° BTDC
Thermostat	160° F (71° C)

[1] Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

[2] Measured using an accurate service tachometer with engine at normal operating temperature.

[3] Timing must be set using a special procedure as outlined in the appropriate section of Service Manual 24 90–861327--1. Timing cannot be properly set using the conventional method.

[4] Idle speed on EFI models is not adjustable.

[5] Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

INDEX

MIE (Inboard)

Model	MX 6.2 MPI
Propshaft Horsepower	320[1]
Propshaft Kilowatts	239[1]
Number of Cylinders	V-8
Displacement	377 cid (6.2 l)
Bore / Stroke - in. (mm)	4.00 x 3.75 in. (101.6 x 95.25)
Compression Ratio	9.0:1
Compression Pressure	100 psi (690 kPa)[5]
Idle rpm In Neutral[2]	600 rpm[4]
Maximum rpm (at WOT)	4800-5200
Oil Pressure (at 2000 rpm)	Minimum 30 psi (207 kPa)
Minimum Oil Pressure (at Idle)	4 psi (28 kPa)
Fuel Pressure (1800 rpm)	30 psi (207 kPa)
Electrical System	12 V Negative (–) Ground
Alternator Rating – Cold Operating Amps	72 Amp
Alternator Rating – Hot Operating Amps	65 Amp
Minimum Battery Requirements	550 cca/700 mca/120 Ah
Firing Order	1-8-4-3-6-5-7-2
Spark Plug Type	AC - MR43LTS Champion - RSY9C NGK - BPR6EFS
Spark Plug Gap	.045 in. (1.1 mm)
Timing (at idle rpm)[3]	8° BTDC
Thermostat	160° F (71°C)

[1] Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

[2] Measured using an accurate service tachometer with engine at normal operating temperature.

[3] Timing must be set using a special procedure as outlined in the appropriate section of Service Manual 24 90–861327--1. Timing cannot be properly set using the conventional method.

[4] Idle speed on EFI models is not adjustable.

[5] Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

INDEX

Ski

Model	MX 6.2 BLACK SCORPION
Propshaft HorsePower	340[1]
Propshaft Kilowatts	254[1]
Number of Cylinders	V-8
Displacement	377 cid (6.2 l)
Bore / Stroke - in. (mm)	4.00 x 3.75 in. (101.6 x 95.25 mm)
Compression Ratio	9.0:1
Compression Pressure	Minimum100 psi (690 kPa)[5]
Idle rpm In Neutral[2]	600 rpm[4]
Maximum rpm (at WOT)[2]	4600 - 5000
Oil Pressure (at 2000 rpm)	Minimum 30 psi (207 kPa)
Minimum Oil Pressure (at Idle)	4 psi (28 kPa)
Fuel Pressure (1800 rpm)	30 psi (207 kPa)
Electrical System	12 V Negative (–) Ground
Alternator Rating – Cold Operating Amps	72 Amps
Alternator Rating – Hot Operating Amps	65 Amps
Minimum Battery Requirements	550 cca / 700 mca / 120 Ah
Firing Order	1-8-4-3-6-5-7-2
Spark Plug Type	NGK - BPR5EFVX NGK - BPR6EFS
Spark Plug Gap	.035 in. (0.9 mm)
Timing (at idle rpm)	8° BTDC[3]
Thermostat	160° F (71°C)

[1] Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

[2] Measured using an accurate service tachometer with engine at normal operating temperature.

[3] Timing must be set using a special procedure as outlined in the appropriate section of Service Manual 24 90–861327--1. Timing cannot be properly set using the conventional method.

[4] Idle speed on EFI models is not adjustable.

[5] Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

Fluid Capacities

NOTICE
Unit Of Measurement: U.S. Quarts (Liters)
All capacities are approximate fluid measures.

Engines

IMPORTANT: It may be necessary to adjust oil levels depending on installation angle and cooling systems (heat exchanger and fluid lines).

Model	377 cid / 6.2L
Crankcase Oil (With Filter) [1]	5.5 (5.25)
Seawater Cooling System [2]	15 (14.1)
Closed Cooling System	20 (19)

[1] Always use dipstick to determine exact quantity of oil or fluid required.

[2] Seawater Cooling System capacity information is for winterization use only.

Sterndrives

NOTICE
Unit Of Measurement: U.S. Fluid Ounces (Milliliters)
All capacities are approximate fluid measures.

Model	BRAVO ONE	BRAVO TWO	BRAVO THREE
Drive Unit Oil Capacity (With Gear Lube Monitor)	88 (2603)	104 (3076)	96 (2839)

INDEX

Transmissions

NOTICE
Unit Of Measurement: U.S. Quarts (Liters) **All capacities are approximate fluid measures.**

NOTE: *Always use dipstick to determine exact quantity of fluid required.*

Make and Model	Capacity	Fluid Type
Velvet Drive 71C[1]	2-1/4 (2.13)	Mobil 424 or Dexron III Automatic Transmission Fluid
72C		Do Not Mix!
5000A 5000V[1]	2-1/2 (2.4) 3 (2.75)	Dexron III Automatic Transmission Fluid
Walter V-Drive Model RV-36[1]	3/4 (0.5)	SAE 30 Heavy Duty Motor Exxon Spartan, EP-68 Gear Oil, APG-80 Gear Oil
ZF (Hurth) 630V 630A 800A	 4-1/4 (4.0) 3-1/4 (3.0) 5-3/4 (5.5)	Dexron III Automatic Transmission Fluid

[1] Fluid should be circulated and then rechecked. Add additional fluid as necessary.

20-Hour Break-In Period

IMPORTANT: The first 20 hours of operation is the engine break-in period. Correct break-in is essential to obtain minimum oil consumption and maximum engine performance. During this break-in period, the following rules must be observed:

- Do not operate below 1500 rpm for extended periods of time for first 10 hours. Shift into gear as soon as possible after starting and advance throttle above 1500 rpm **if conditions permit safe operation.**
- Do not operate at one speed consistently for extended periods.
- Do not exceed 3/4 throttle during first 10 hours. During next 10 hours, occasional operation at full throttle is permissible (5 minutes at a time maximum).
- Avoid full throttle acceleration from IDLE speed.
- Do not operate at full throttle until engine reaches normal operating temperature.

After Break-in Period

To help extend the life of your Mercury MerCruiser power package, the following recommendations should be considered;

- Use a propeller that allows the engine to operate at or near the top of the maximum rpm range (refer to “Specifications” section) when at full throttle with a normal boat load.
- Operation at 3/4 throttle setting or lower is recommended. Refrain from prolonged operation at maximum (full throttle) rpm.

End of First Season Checkup

At the end of the first season of operation, an Authorized Mercury MerCruiser Dealer should be contacted to discuss and/or perform various scheduled maintenance items. If you are in an area where the product is operated continuously (year-round operation), you should contact your dealer at the end of the first 100 hours of operation, or once yearly, whichever occurs first.

CA261

Specifications

Fuel Recommendations

IMPORTANT: Use of improper gasoline can damage your engine seriously. Engine damage resulting from use of improper gasoline is considered misuse of engine and damage caused thereby will not be covered under the limited warranty.

FUEL RATINGS

Mercury MerCruiser engines will operate satisfactorily when using a major brand of unleaded gasoline as follows:

USA and Canada - having a posted pump Octane Rating of 87 (R+M)/2 minimum. Premium gasoline [92 (R+M)/2 Octane] is also acceptable. DO NOT use leaded gasoline.

Outside USA and Canada - having a posted pump Octane Rating of 90 RON minimum. Premium gasoline (98 RON) is also acceptable. If unleaded gasoline is not available, use a major brand of leaded gasoline.

CA291

USING REFORMULATED (OXYGENATED) GASOLINES (USA ONLY)

This type of gasoline is required in certain areas of the USA. The two types of “oxygenates” used in these fuels are Alcohol (Ethanol) and Ether (MTBE or ETBE). If Ethanol is the “oxygenate” that is used in the gasoline in your area, refer to “Gasolines Containing Alcohol.”

These “Reformulated Gasolines” are acceptable for use in your Mercury MerCruiser engine.

VAPOR LOCKING

Fuels containing alcohol and winter grade fuels will aggravate vapor lock problems. A vapor lock condition can be identified by the following problems:

- Engine starts and, upon advancing throttle, shuts off and will not restart.
- If engine does restart, it shuts off when advancing throttle.
- Engine is difficult to restart after operating the boat and then leaving the engine off for 1 to 3 hours.

Other factors may combine to increase vapor locking. These factors include but are not limited to:

- Fuel temperature at the fuel inlet on the engine must not exceed 110°F (43°C)
- Engine compartment temperature during a heat soak condition must not exceed 170°F (80°C)
- Max vacuum on the inlet side of the fuel pump must not exceed 2 inHg (6.9 kPa)

Other conditions should be ruled out before treating the problem as vapor locking.

CA618

GASOLINES CONTAINING ALCOHOL

If the gasoline in your area contains either “methanol” (methyl alcohol) or “ethanol” (ethyl alcohol), you should be aware of certain adverse effects that can occur. These adverse effects are more severe with “methanol.” Increasing the percentage of alcohol in the fuel can also worsen these adverse effects.

Some of these adverse effects are caused because the alcohol in the gasoline can absorb moisture from the air, resulting in a separation of the water/alcohol from the gasoline in the fuel tank.

The fuel system components on your Mercury MerCruiser engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat’s fuel system will withstand. Contact your boat manufacturer for specific recommendations on the boats fuel system components (fuel tanks, fuel lines and fittings). Be aware that gasolines containing alcohol may cause increased:

- Corrosion of metal parts.
- Deterioration of rubber or plastic parts.
- Fuel permeation through rubber fuel lines.
- Starting and operating difficulties.

⚠ WARNING

FIRE AND EXPLOSION HAZARD: Fuel leakage from any part of fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic, metal or fiberglass, fuel lines, fittings, fuel filters and carburetors/fuel injection components should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration requires replacement before further engine operation.

Because of possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only fuel containing alcohol is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

IMPORTANT: When operating a Mercury MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods should be avoided. Long periods of storage, common to boats, create unique problems. In cars alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

INDEX

Test For Alcohol Content In Gasoline

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. Use any small transparent bottle or tube that can be capped and is, or can be, provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

PROCEDURE

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space, then cap the container. The proportions of fuel to water are not critical, but there should be 2 to 3 times as much fuel as water.
3. Shake container vigorously and allow it to sit **upright for 3 to 5 minutes**. If the volume of water appears to have increased, alcohol is present. If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

Transmission Fluid

Velvet Drive - Dexron III Automatic Transmission Fluid

Walter V-Drive - SAE 30 Heavy Duty Motor, Exxon Spartan EP-68 Gear Oil or APG-80 Gear Oil.

Hurth - Dexron III Automatic Transmission Fluid

Power Steering Fluid

Use Quicksilver Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid (ATF).

Coolant for Closed Cooling System

⚠ CAUTION

Alcohol or Methanol base antifreeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

We recommend that the coolant section of closed cooling system be filled with Extended Life Ethylene Glycol 5/100 Antifreeze/Coolant mixed 50/50 with purified water. In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

If any non-compatible coolant is added to this coolant, coolant must be changed every 2 years or 400 hours, whichever occurs first. All coolants other than Extended Life 5/100 Ethylene Glycol Antifreeze/Coolant must be changed every 2 years or 400 hours, whichever occurs first.

Mercury MerCruiser V-8 engines can use any type of permanent antifreeze or any brand antifreeze solution that meets GM specification 1825M.

CA693

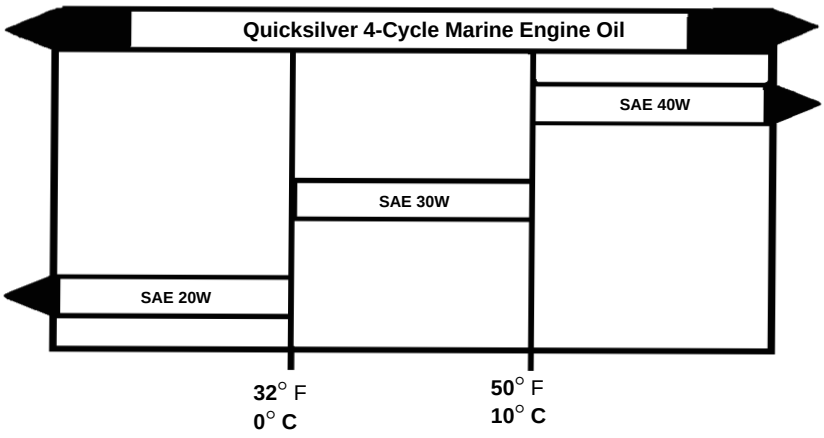
Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle 25W-40 Marine Engine Oil. This oil is a special blend of 25-weight and 40-weight oils for marine engines. If not available, a good grade, straight weight, detergent automotive oil of correct viscosity, with an API classification of SH,CF/CF-2, may be used.

In those areas where Quicksilver 4-Cycle 25W-40 Marine Engine Oil or a recommended straight weight oil are not available, a multiviscosity 20W-40 (SH, CF/CF-2) or, as a second but less preferable choice, 20W-50, with API service ratings of SH, CF/CF-2 may be used.

IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than Quicksilver 25W-40 or a good quality 20W-40 or 20W-50), synthetic oils, low quality oils or oils that contain solid additives are specifically not recommended.

The chart below is a guide to crankcase oil selection. The oil filter should always be changed with oil.



Overfilled Crankcase Oil

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm “clatter” on Mercury MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to “bleed down.” This, in turn, results in rocker arm “clatter” and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the ADD mark and the FULL mark on the dipstick. To ensure that you are not getting a “false reading,” make sure the following steps are done before checking the oil level.

- Boat “at rest” in the water, or
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting “at rest” in the water.
- Allow sufficient time for oil to drain into the crankcase if engine has just been run or oil has just been added.

INDEX

Checking Engine Oil Level / Filling

IMPORTANT: ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN "MAINTENANCE SCHEDULE" CHART. It is normal for an engine to use a certain amount of oil in the process of lubrication and cooling of the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide-open-throttle and decreasing substantially as engine speed is reduced.

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick.
4. Wipe clean and reinstall. Push dipstick all the way into dipstick tube.
5. Remove dipstick and note the oil level.
6. Oil level must be between the FULL or OP RANGE and ADD marks.
7. If oil level is below ADD mark, proceed to Steps 8. and 9.
8. Remove oil filler cap from valve rocker arm cover.
9. Add required amount of oil to bring level up to, but not over, the FULL mark on dipstick.

INDEX

Changing Oil and Filter

1. Start engine and run until it reaches normal operating temperatures.

IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.

2. Stop engine.
3. Remove drain plug from oil pan or from oil drain hose.

NOTE: *If drain plug is not accessible because of boat construction, oil may be removed through dipstick tube, using a Quicksilver Crankcase Oil Pump. (See Quicksilver Accessory Guide.)*

4. After oil has drained completely, reinstall drain plug (if removed) and tighten securely.
5. Remove and discard oil filter and its sealing ring.
6. Coat sealing ring on new filter with engine oil, and install. Tighten filter securely (following filter manufacturer's instructions). Do not overtighten.
7. Fill crankcase with oil. See "Specifications" for type of oil and quantity.
8. Start engine and check for leaks.

Changing Water Separating Fuel Filter

⚠ WARNING

Be careful when changing water separating fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Be sure ignition key is OFF. Do not smoke or allow spark or open flame in area when changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠ CAUTION

The electric fuel pump and factory installed water separating fuel filter have been carefully designed to function properly together. Do not install additional fuel filters and/or water separating fuel filters between fuel tank and engine.

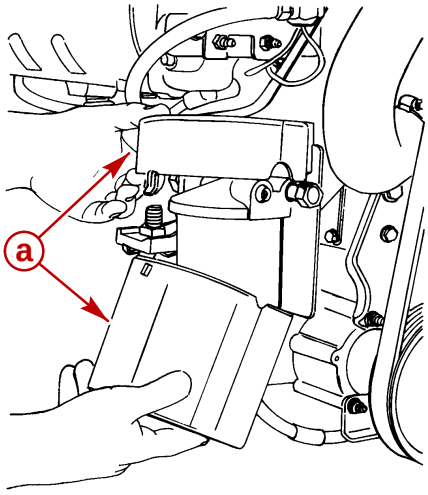
The installation of additional filters may cause:

- Fuel Vapor Locking
- Difficult Warm-Starting
- Piston Detonation Due to Lean Fuel Mixture
- Poor Driveability

INDEX

MCM (Sterndrive) Models

1. MCM (sterndrive) models only: Unsnap latch and slide top and bottom cover pieces from around the water separating fuel filter and bracket.



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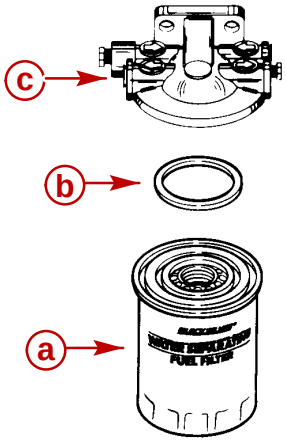
a - Fuel Filter Cover

NOTE: *Top and bottom cover pieces are formed with a groove on each side that slides around the brackets outer edges.*

2. Remove water separating fuel filter and sealing ring from mounting bracket and discard.



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a - Fuel Filter
b - Sealing Ring
c - Mounting Bracket

3. Coat sealing ring on new filter with motor oil.
4. Thread filter onto bracket and tighten securely by hand. Do not use a filter wrench.
5. Start and run engine.
6. Check filter connection for gasoline leaks. If leaks exist, recheck filter installation.
7. MCM models only: Install cover pieces around fuel filter. Be certain top part of cover latches to lower part.

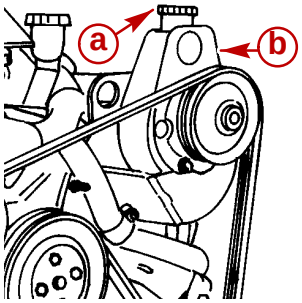
INDEX

Power Steering System

Checking Fluid Level

ENGINE WARM

1. Stop engine. Position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump and note fluid level.



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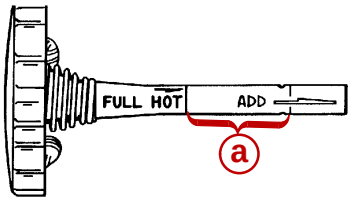
d - Fill Cap / Dipstick
e - Power Steering Pump

3. Level should be between the FULL HOT mark and ADD mark on dipstick.



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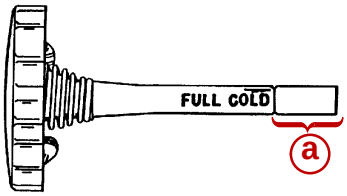
a - Proper Fluid Level with Engine Warm

4. If level is below ADD mark, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid (ATF) through fill cap opening, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

Engine Cold

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump and note fluid level.
3. Level should be between FULL COLD mark and bottom of dipstick.



72519

a - Proper Fluid Level with Engine Cold

INDEX

4. If level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid (ATF), through fill cap opening, to bring level up to FULL COLD mark on dipstick. DO NOT OVERFILL.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

Filling and Bleeding

IMPORTANT: Power steering system must be filled exactly as explained in the following to be sure that all air is bled from the system. All air must be removed or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid may cause power steering system to become spongy, resulting in poor boat control.

1. With engine stopped, position sterndrive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump.
3. Add Quicksilver Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid (ATF), as required, to bring level up to FULL COLD mark on dipstick.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid or Dexron Ill automatic transmission fluid (ATF), in power steering system.

4. Turn steering wheel back and forth to end of travel in each direction several times.
5. Recheck fluid level and add fluid, if necessary.
6. Install vented fill cap. Tighten securely.

⚠ CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump, or pump impeller may be damaged and subsequent overheating damage to engine may result.

7. Start engine and run at fast idle (1000-1500 rpm) until engine reaches normal operating temperature. During this time, turn steering wheel back and forth to end of travel in each direction several times.
8. Position sterndrive unit so that it is straight back and stop engine.
9. Remove fill cap from pump.
10. Allow any foam in pump reservoir to disperse.
11. Check fluid level and add fluid, as required, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL**.**
12. Reinstall fill cap. Tighten securely.

IMPORTANT: Sterndrive unit must be positioned straight back and power steering fluid must be hot to accurately check fluid level.

NOTE: *If fluid is still foamy, repeat Steps 7. through 12. until fluid does not foam and level remains constant.*

INDEX

Closed Cooling System

Checking Coolant Level

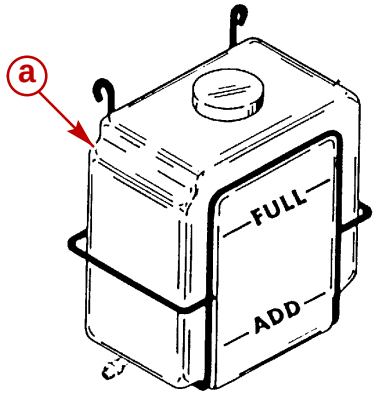
⚠ CAUTION

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and remove cap.

1. Coolant level in heat exchanger should be full (to bottom of filler neck).

IMPORTANT: When reinstalling pressure cap, tighten it until it contacts the filler neck.

2. Coolant level should be between the ADD and FULL marks on coolant recovery reservoir with the engine at normal operating temperature.



72520

a - Coolant Recovery Reservoir

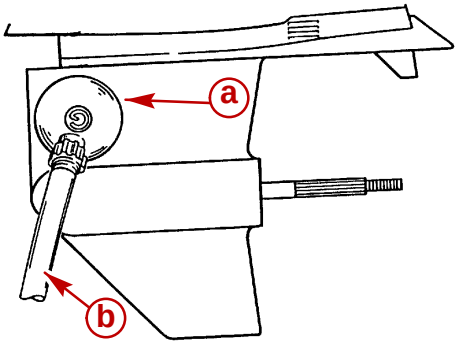
Flushing System MCM (Sterndrive)

If engine is operated in salty, polluted or mineral-laden water, flush seawater cooling system (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Thoroughly flush the seawater cooling system prior to storage.

NOTE: *For additional protection against freezing and rust to the exhaust manifolds and other components, a 50-50 mixture of antifreeze and water can be run through the engine during Power Package Layup.*

BOAT OUT OF WATER

1. Install flushing attachment over water pickup holes in gear housing as shown.
2. Attach a water hose between the flushing attachment and a water tap.



72693

a - Flushing Attachment
b - Hose

⚠ WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

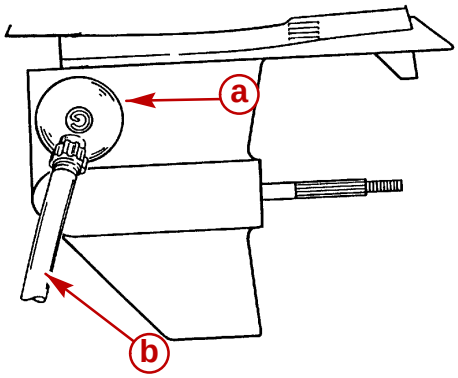
Watch temperature gauge on dash to ensure that engine does not overheat.

3. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full water pressure.
4. Place remote control in NEUTRAL, idle speed position, and start engine.
5. Operate engine at idle speed in NEUTRAL for 10 minutes, or until discharge water is clear, then stop engine.
6. Shut off water tap. Remove water hose and flushing attachment.

INDEX

BOAT IN WATER

1. Raise drive unit to full UP position.
2. Install flushing attachment over water pickup holes in gear housing as shown.
3. Attach a water hose between the flushing attachment and a water tap.



72693

a - Flushing Attachment
b - Hose

4. Lower drive unit to full IN position.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

5. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full water pressure.
6. Place remote control in NEUTRAL, idle speed position, and start engine.
7. Operate engine at idle speed in NEUTRAL for 10 minutes, then stop engine.
8. Shut off water tap.
9. Raise drive unit to full UP position.
10. Remove water hose and flushing attachment.

INDEX

Flushing System MIE (Inboard and Ski)

⚠ CAUTION

If boat is in the water, seacock, if so equipped, must remain closed until engine is to be re-started to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged (to prevent water from flowing back into cooling system and/or boat). As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning: Open seacock or reconnect water inlet hose before starting engine.

IMPORTANT: If a seacock is to be installed for this purpose, valve used must have an internal cross-sectional area equal to or greater than water inlet hose to prevent restricting water flow during normal operation. A 1-1/4 in. (32 mm), or larger, brass ball valve or gate valve is recommended.

1. If boat is in water, close seacock or disconnect and plug seawater inlet hose to prevent seawater from entering boat.
2. Remove inlet hose from seawater pickup pump.
3. Using an adaptor, connect a water hose from a water tap to seawater pump inlet.
4. Partially open water tap (approximately 1/2 maximum capacity). Do not use full water pressure.
5. Place the remote control lever in NEUTRAL position and start engine.

⚠ WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

6. Operate engine at idle speed in NEUTRAL for 10 minutes or until discharge water is clear. Stop engine.
7. Shut off water tap. Remove water hose and adaptor from pump inlet and reconnect water inlet hose. Be sure to tighten hose clamp securely.

IMPORTANT: If boat is in the water, do not open water inlet valve until engine is to be restarted to prevent contaminated water from flowing back into engine. If boat is not fitted with a valve, leave water inlet hose disconnected and plugged.

INDEX

Transmission Fluid

NOTE: *Due to the various installation angles and oil cooler set-ups, it may be necessary to adjust oil level.*

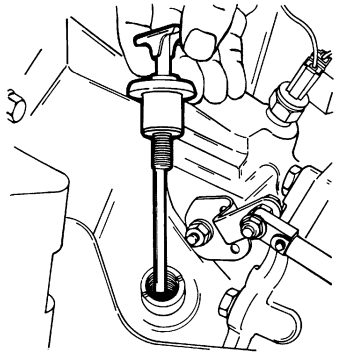
⚠ WARNING

Do not remove dipstick with engine running. Hot oil can cause burns.

⚠ CAUTION

Clean around the area of the dipstick before removing. Small particles of dirt can cause damage to internal components and cause valves to stick.

IMPORTANT: DO NOT allow fluid level to drop below the bottom line.



72526

TRANSMISSION WARM

The transmission should be at operating temperature (190° maximum) to get an accurate oil level reading. Oil will expand when heated. Oil will drain back from the cooler. Expansion and drain-back can significantly affect oil level.

1. When the transmission is at operating temperature, place selector lever in neutral.
2. Shut off engine.
3. Carefully remove dipstick and wipe clean.
4. Immediately insert clean dipstick and read oil level.

NOTE: *Oil level must be checked immediately after engine shut-down to prevent an incorrect reading. Oil drains back into the transmission from the cooler and cooler lines.*

5. Add or remove oil as necessary until the oil is at the required mark.

TRANSMISSION COLD

NOTE: *For ease of checking the oil prior to engine start-up, a cold oil level mark can be made. To find the cold oil level mark, the oil level must first be set according to the warm oil level checking procedure.*

1. After ensuring the correct oil level with the transmisson at normal operating temperature, let the boat sit overnight. Insert clean dipstick and read level.
2. Put a mark on the dipstick at the cold oil level.

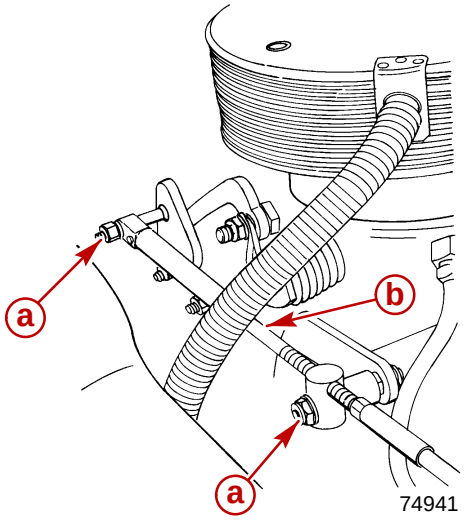
NOTE: *You can use the new mark to check the oil level when cold. If oil level adjustment is needed, add oil to the new mark. This procedure can be performed by the builder, dealer or owner to ease fluid checking procedure.*

INDEX

Lubrication

Throttle Cable

1. Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.

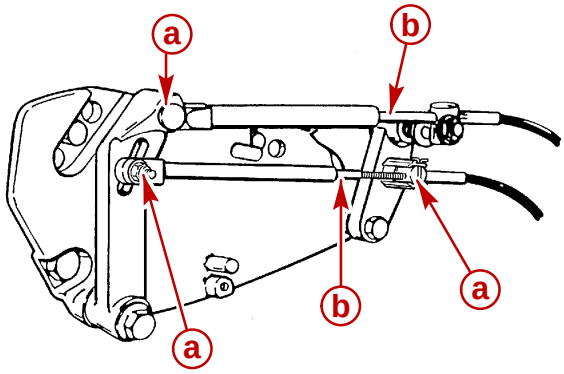


a - Pivot Points
b - Guide Contact Surface

Shift Cable and Transmission Linkage

MCM (STERNDRIVE) MODELS

1. Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.

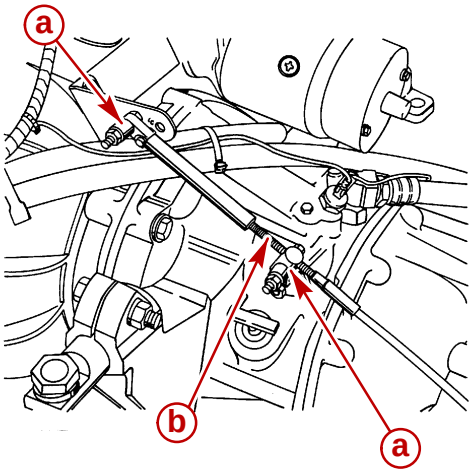


Typical Shift Cable

a - Pivot Points
b - Guide Contact Surface

MIE (INBOARD AND SKI) MODELS

1. Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.

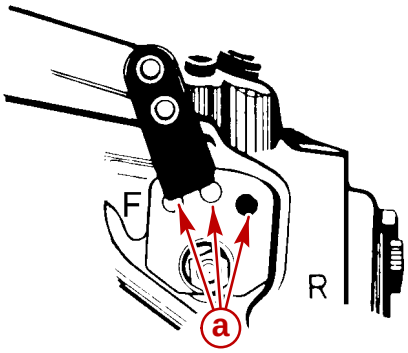


72528

Typical Shift Cable

a - Pivot Points
b - Guide Contact Surface

2. Lubricate detent ball and holes in lever with SAE 30W motor oil.



71457

Typical In-Line Transmission

a - Poppet Ball Locations

INDEX

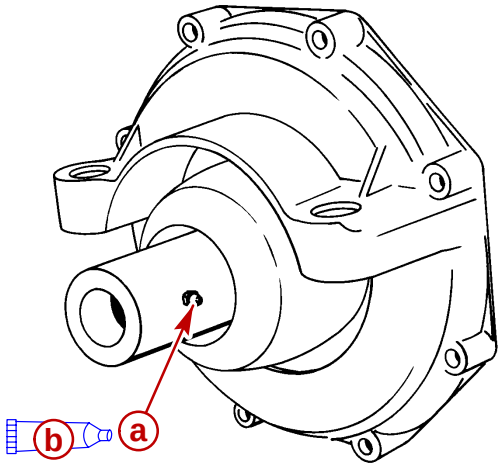
Engine Coupler/U-Joint Shaft Splines

NOTE: *Engine coupler and shaft splines are greased with Quicksilver Engine Coupler Spline Grease, 92-816391A4; universal joints are greased with Quicksilver 2-4-C Marine Lubricant.*

NOTE: *Refer to Mercury MerCruiser Sterndrive Service Manual for sterndrive unit removal and installation, if necessary.*

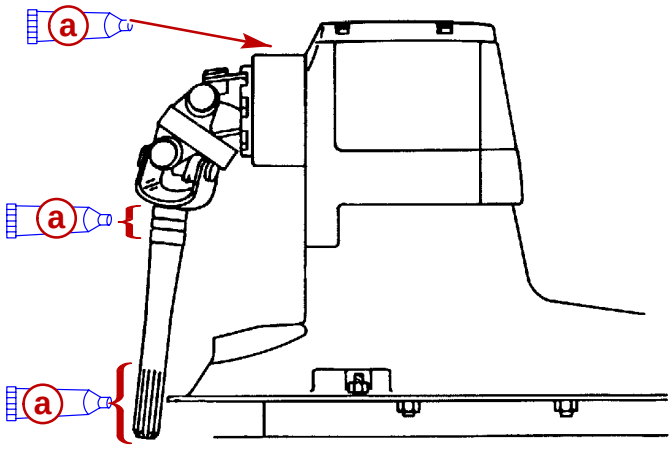
IMPORTANT: Sterndrive Unit does not have to be removed to grease coupler.

1. Lubricate engine coupler splines through grease fitting on coupler by applying approximately 8-10 pumps of grease from a typical hand-operated grease gun.



71569

a - Grease Fitting
b - Quicksilver Engine Coupler Spline Grease



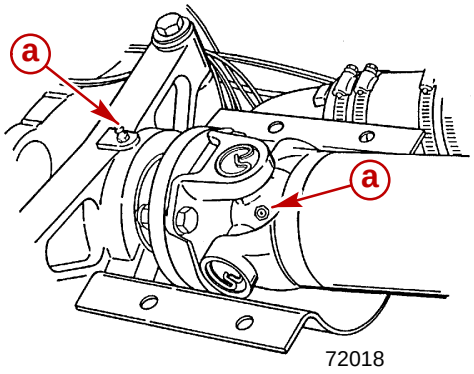
72531

Typical Bravo Drive

a - Quicksilver Engine Coupler Spline Grease

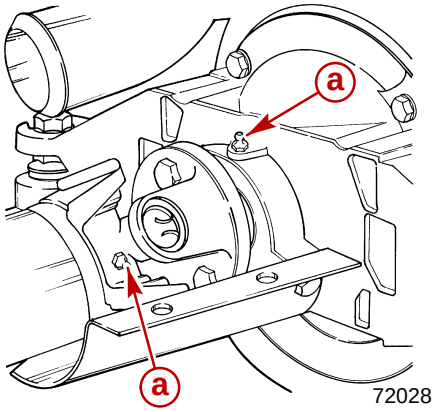
INDEX

Sterndrive Drive Shaft Extension Models



72018

Transom End



72028

Engine End

a - Grease Fitting

Starter Motor

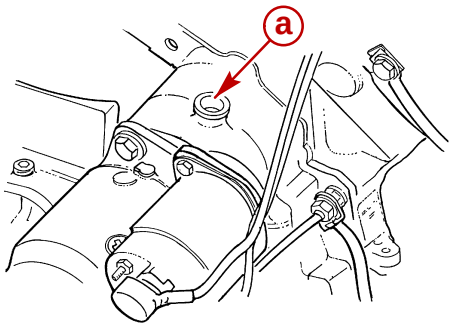
MIE (INBOARD AND SKI) MODELS

⚠ WARNING

When performing the following procedure, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of a fire.**
- **Be sure to ground coil high-tension wire to block. Failure to ground coil wire may cause damage to ignition coil in addition to being a safety hazard.**
- **Stay clear of all moving parts.**

1. Remove ignition coil high-tension wire from distributor cap tower and ground it to engine block with jumper wire.
2. While cranking engine with starter motor, lubricate starter motor front bushing through oil cover with motor oil or equivalent.
3. Reinstall coil high-tension wire.
4. Remove plastic plug from flywheel housing.
5. Lubricate starter motor shaft with motor oil through hole in flywheel housing.
6. Reinstall plastic plug.



72019

a - Grease Fitting

INDEX

Cleaning Flame Arrestor

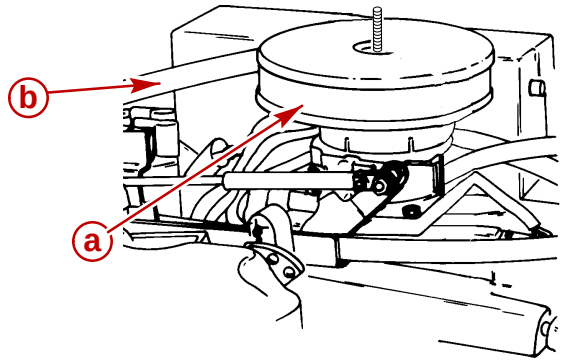
⚠ WARNING

Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. Be careful when cleaning flame arrestor and crankcase ventilation hoses. Be sure that ignition is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hoses.

⚠ WARNING

Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. NEVER use gasoline as a cleaning solvent.

1. Remove crankcase ventilation hose from fitting on side of flame arrestor housing.
2. Remove flame arrestor.



76501

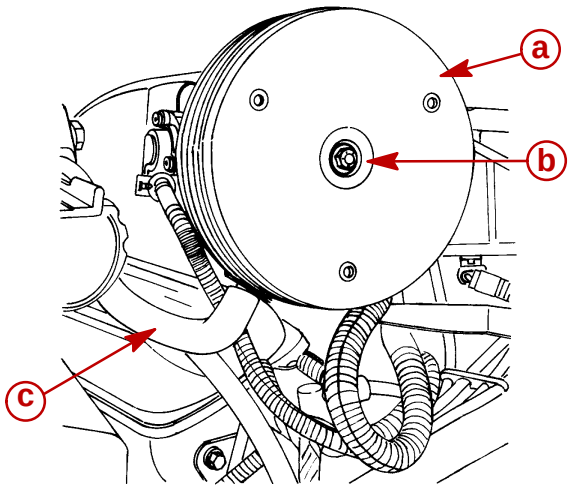
a - Flame Arrestor
b - Crankcase Ventilation Hose

3. Clean flame arrestor in solvent. Blow dry with compressed air.
4. Clean crankcase ventilation hose in solvent. Blow dry with compressed air.
5. Inspect crankcase ventilation hose for cracks or deterioration and replace if necessary.
6. Reinstall flame arrestor and and crankcase ventilation hose.
7. Reinstall flame arrestor nut and tighten securely.

INDEX

Black Scorpion Flame Arrestor

1. Remove clamp or nut, as applicable.
2. Remove crankcase ventilation hose.
3. Remove flame arrestor.



75779

a - Flame Arrestor
b - Nut
c - Vent Hose

4. Clean flame arrestor in solvent. Blow dry with compressed air.
5. Clean crankcase ventilation hoses in solvent. Blow dry with compressed air.
6. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.
7. Install flame arrestor and related components.
8. Tighten clamp or nut securely.

Serpentine Drive Belt

Component Location

⚠ WARNING

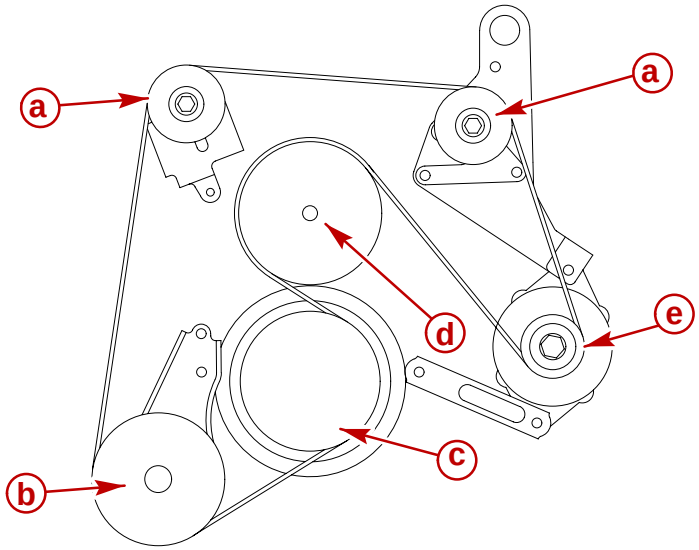
Avoid possible serious injury. Make sure engine is shut off and ignition key is removed before inspecting belt.

IMPORTANT: MIE ENGINES ONLY: The brackets and washers on the 3 idler pulleys must be in a certain order or the belt will come off of the serpentine belt. All pulleys are referenced as though you were standing in front of the engine looking at the belt.

- Upper Right Idler Pulley Bracket Stud: Stud is threaded into the cylinder head. From the cylinder head is a nut, a flat washer, the lifting eye bracket, the oil cooler bracket, the idler pulley bracket and then a nut.
- Upper Left Idler Pulley Bracket Bolt: From the cylinder head is an idler pulley bracket, a flat washer, the heat exchanger bracket, a flat washer and the head of the bolt.
- Lower Idler Pulley Bracket Bolt: From the cylinder block is an idler pulley bracket and then the head of the bolt.

INDEX

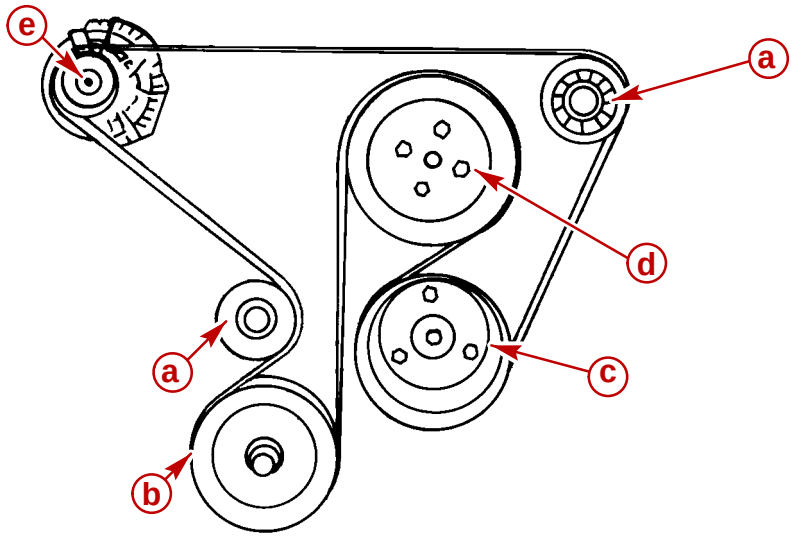
NOTE: *Some models will have components arranged in a different order. All configurations are not shown. Checking, replacing and adjustment procedures are the same.*



76389

Typical Inboard Model

- **a** - Idler Pulley
- **b** - Seawater Pump Pulley
- **c** - Crankshaft Pulley
- **d** - Circulating Pump Pulley
- **e** - Alternator Pulley



76463

Typical Sterndrive Model

- **a** - Idler Pulley
- **b** - Seawater Pump Pulley
- **c** - Crankshaft Pulley
- **d** - Circulating Pump Pulley
- **e** - Alternator Pulley

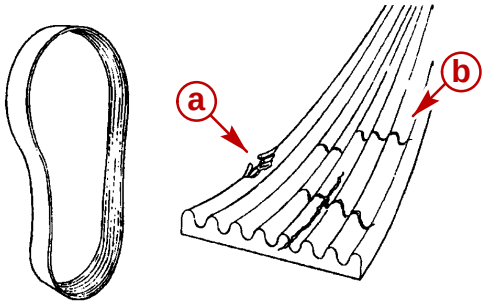
Inspection

1. Inspect drive belt for the following:

- Excessive wear
- Cracks

NOTE: Minor, transverse cracks (across the belt width) may be acceptable. Longitudinal cracks (in direction of belt length) that join transverse cracks are NOT acceptable.

- Fraying
- Glazed surfaces



75130

a - Fraying
b - Cracks

Replacing and/or Adjusting Tension

REMOVAL

1. Loosen 5/8 in. locking nut on adjustment stud.
2. Turn adjustment stud and loosen belt.
3. Remove drive belt.

INSTALLATION AND ADJUSTMENT

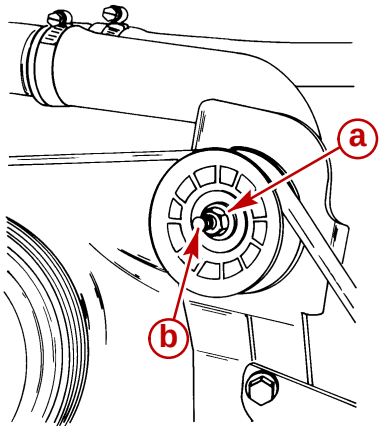
1. Install drive belt on pulleys.
2. Adjust tension by loosening 5/8 in. locking nut on adjustment stud. Leave wrench on adjustment stud.

NOTE: *Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys. Proper tension is 1/4 in. (6 mm) deflection with moderate thumb pressure.*

3. Use 5/16 in. socket and tighten adjusting stud until the correct deflection of the belt is obtained at location specified above.

INDEX

4. While holding adjustment stud at the correct belt tension, tighten 5/8 in. locking nut.
5. Run engine for a short period of time and recheck belt adjustment.



7490

a - 5/8 in. Locking Nut
b - 5/16 in Adjusting Stud

Ignition Timing

EFI/MPI Models

1. Connect timing light to number 1 spark plug wire.
2. Start engine and run at 1300 rpm until it reaches normal operating temperature.
3. Stop engine and connect the scan tool or timing tool to the DLC connector on the wiring harness.
4. Start engine, allow rpm to stablilize.

NOTE: *ECM will automatically adjust engine rpm to approximately 1200 rpm when put in the service mode on a scan tool or when using the timing tool.*

5. Check igniton timing. If incorrect, rotate the distributor until timing is correct. Torque clamping screw to 18 lb-ft (25 Nm).
6. Recheck ignition timing.
7. Disconnect scan tool or timing tool from DLC connector.
8. If required, return remote control throttle lever to idle position and shut off engine.
9. Restart engine, increase rpm to 1300 then return to idle position slowly. Ensure that engine returns to idle rpm. Readjust throttle cable, if required.
10. Shut engine off.

Cold Weather or Extended Storage

Precautions

⚠ WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF and do not smoke or allow sources of spark and/or open flames in the area.

⚠ WARNING

Avoid Fire or Explosion: To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

⚠ WARNING

Avoid Fire or Explosion: Fuel injection system is pressurized during operation. Use care when removing water separating fuel filter. Fuel could spray on hot engine causing fire or explosion. Allow engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it to help avoid fuel spraying on the engine.

⚠ CAUTION

If boat is in the water, seacock (water inlet valve), if equipped, must be closed until engine is to be restarted, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure attach a tag to the ignition switch or steering wheel of the boat with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting engine.

⚠ CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

⚠ CAUTION

If engine is equipped with Closed Cooling System, Closed Cooling section must be kept filled with a solution of ethylene glycol antifreeze and water (mix antifreeze to manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). DO NOT USE PROPYLENE GLYCOL antifreeze in closed cooling section. Seawater section, however, must be drained completely.

⚠ CAUTION

A discharged battery can be damaged by freezing.

INDEX

⚠ CAUTION

Seawater section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.

IMPORTANT: Observe the following information to ensure complete draining of cooling system.

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages.**

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting during storage, reinstall drain plugs. Never leave drain plugs out during storage.

NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

Power Package Layup

NOTICE

Refer to "Cold Weather or Extended Storage Precautions" in this section BEFORE proceeding.

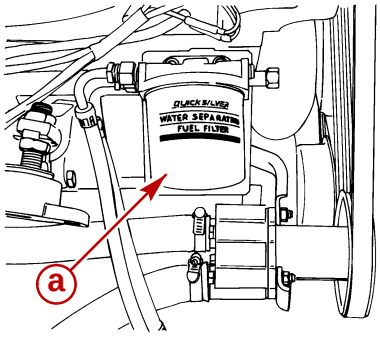
IMPORTANT: Mercury MerCruiser strongly recommends that this service be performed by an Authorized Mercury MerCruiser Dealer. Damage caused by freezing IS NOT covered by the MerCruiser Limited Warranty.

1. Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines to treat gasoline. Follow instructions on container. Run the boat for 20 to 30 minutes before docking to properly mix it with the fuel in the tank and to get into the engine's fuel system.
2. **If boat is to be placed in storage with fuel containing alcohol in fuel tanks (if fuel without alcohol is not available):** Fuel tanks should be drained as low as possible and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to "Fuel Requirements" for additional information. Run the boat for 20 to 30 minutes before docking to properly mix it with the fuel in the tank and to get into the engine's fuel system.

NOTE: *If desired, a portable fuel tank can be used to perform the remainder of the power package layup procedures. Be sure to add an appropriate amount of Gasoline Stabilizer to the portable tank.*

3. Shut off engine.
4. Change oil and oil filter.
5. Flush cooling system. Refer to "Flushing Cooling System" procedure.
6. Close the fuel shutoff valve, if equipped. If no fuel shutoff valve is present, a suitable method must be employed to STOP the flow of fuel from the fuel tank to the engine before proceeding.

7. Prepare EFI fuel system for extended storage as follows:
   a. Allow engine to cool down.
   b. Remove the water separating fuel filter.
   c. Pour out a small amount of fuel into a suitable container, then add approximately 2 fluid ounces (60 ml) of Quicksilver 2-Cycle Outboard Oil to fuel in the water separating fuel filter.
   d. Reinstall water separating fuel filter.
   e. Start and operate engine at idle speed until the water separating fuel filter and fuel injection system are empty and engine stops.
   f. Remove and discard water separating fuel filter.
   g. Install new filter.



75533

a - Water Separating Fuel Filter

8. Clean flame arrestor and crankcase ventilation hoses and reinstall.
9. Lubricate all items listed in “Lubrication” section.
10. Drain seawater section of cooling system as outlined in “Draining Instructions” section.
11. **On Models with Closed Cooling System:** Test coolant to ensure that it will withstand the lowest temperature expected during storage.
12. Service batteries per manufacturer’s instructions.
13. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II or wipe down with Quicksilver Storage Seal or SAE 20W engine oil.
14. For sterndrive unit layup, refer to appropriate sterndrive service manual.

NOTE: *For additional protection against freezing and rust to the exhaust manifolds and other components, a 50-50 mixture of antifreeze and water can be run through the engine during Power Package Layup.*

INDEX

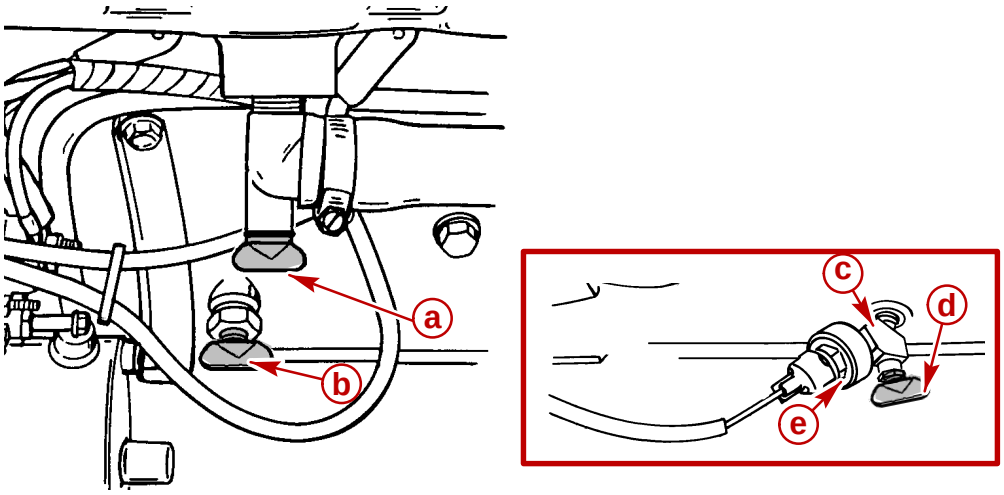
Draining Instructions

DRAINING SEAWATER (RAW-WATER) COOLED MODELS

NOTICE
Refer to “Cold Weather or Extended Storage Precautions” in this section, BEFORE proceeding.

1. Engine must be as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs from bottom of port and starboard manifold fittings.
3. Remove drain plugs (port and starboard) from cylinder block, or cylinder block Y-fitting.

⚠ CAUTION
Avoid product damage. Do not disturb the Y-fitting when removing the drain plug. There is an ignition control “Knock Sensor” in the upper hole of the fitting. This sensor must not be loosened or removed. It is tightened to a critical specification at the factory.



74073

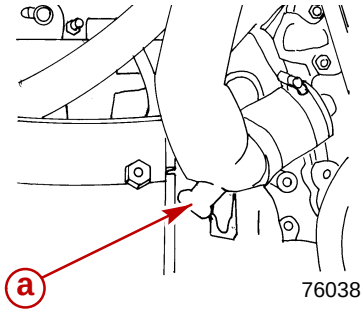
Starboard Side Shown (Port Similar)

- **a -** Exhaust Elbow Drain Plug
- **b -** Cylinder Block Drain Plug
- **c -** Y-Fitting (Fuel Injected Only)
- **d -** Cylinder Block Drain Plug (Fuel Injected Only)
- **e -** Knock Sensor

4. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

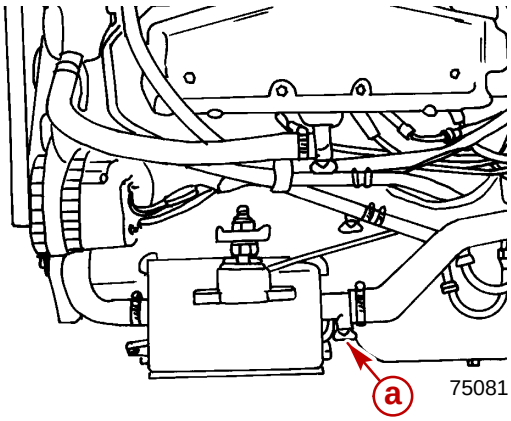
NOTE: *It may be necessary to lift, bend or lower hoses to allow water to drain completely when hoses are disconnected.*

5. Remove the engine water circulating pump drain plug or the lower connection of the water arc pump hose.



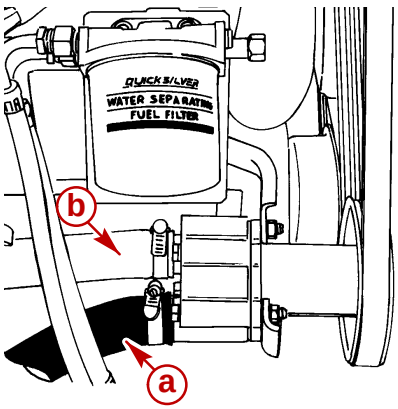
a - Water Circulating Pump Drain Plug

6. Remove the drain plug from the Cool Fuel System cooler.



a - Drain Plug

7. Remove seawater pump inlet hose as shown.



a - Seawater Inlet Hose
b - Hose To Cooler

INDEX

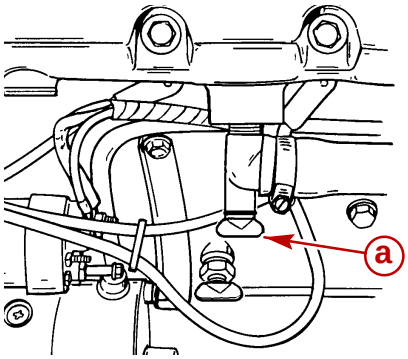
DRAINING SEAWATER SECTION OF CLOSED COOLED (COOLANT) MODELS

MCM (Sterndrive) Models

NOTICE
Refer to “Cold Weather or Extended Storage Precautions” in this section, BEFORE proceeding.

IMPORTANT: Drain seawater section of closed cooling system only.

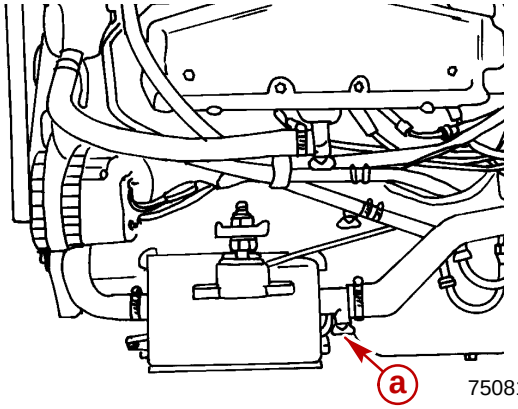
1. Engine must be as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs from bottom of port and starboard exhaust manifolds.



74073

a - Drain Plug

3. Remove the drain plug from the Cool Fuel System cooler.

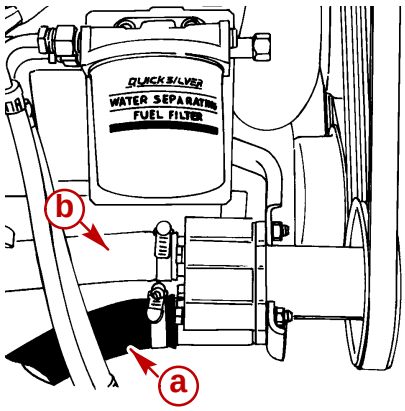


75081

a - Drain Plug

NOTE: *It may be necessary to lift, bend or lower hoses to allow water to drain completely when hoses are disconnected.*

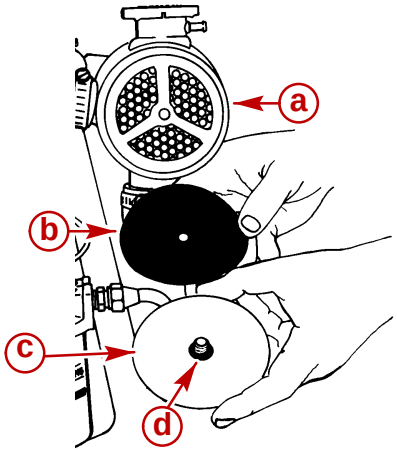
4. Remove seawater pump inlet hose.



75533

a - Seawater Inlet Hose
b - Hose To Cooler

5. Remove end caps, sealing washers and gaskets from the heat exchanger. Allow tubes to drain.



71515

a - Heat Exchanger
b - Sealing Washer
c - End Cap
d - Gasket

IMPORTANT: Use compressed air to blow any remaining water from the tubes in the heat exchanger.

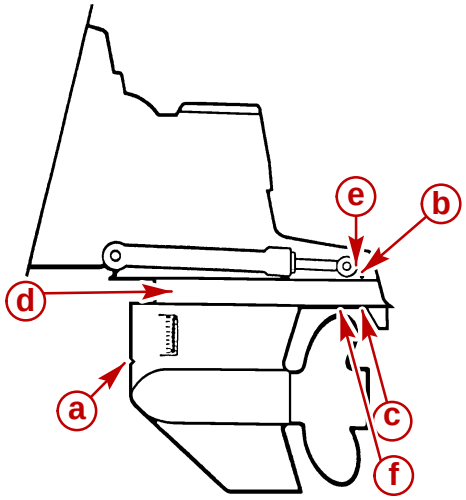
6. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.
7. After seawater section of cooling system has been drained completely:
   a. Install all drain plugs and tighten securely.
   b. Reconnect hoses and tighten all hose clamps securely.
   c. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets.
   d. Assemble new gaskets, new sealing washers and end plates onto heat exchanger. Torque end plate screws to 36-72 lb-in. (4-8 Nm).
   e. **If NOT equipped with seacock:** Seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

INDEX

Draining Sterndrive Unit

NOTICE
Predelivery Preparation Instructions Must Be Performed Before Delivering Boat To The Product Owner.

1. Insert a small wire (repeatedly) to make sure that speedometer pitot tube, anode cavity vent hole and anode cavity drain passage are unobstructed and drained.



71217

Typical

- **a -** Speedometer Pitot Tube
- **b -** Anode Cavity Vent Hole
- **c -** Anode Cavity Drain Passage
- **d -** Gear Housing Water Drain Hole (One Each - Port and Starboard)
- **e -** Gear Housing Cavity Vent Hole
- **f -** Gear Housing Cavity Drain Hole

Recommissioning

NOTICE
Refer to “Cold Weather or Extended Storage Precautions” in this section BEFORE proceeding.

1. Ensure that all cooling system hoses are connected and tight.
2. Ensure all petcocks and drain plugs are installed and tight.
3. Inspect serpentine drive belt for condition and proper tension.
4. Perform all lubrication and maintenance specified for completion “Annually” and “Every 100 hours or Annually” in maintenance schedule, except items which were performed at time of engine layup.
5. For sterndrive unit recommissioning, refer to appropriate Sterndrive Service Manual.

⚠ CAUTION
When installing battery (in next step), be sure to connect positive battery cable to positive (+) terminal and negative (grounded) battery cable to negative (–) battery terminal. If battery cables are reversed, damage to electrical system WILL result.

6. Install fully charged battery. Clean battery cable clamps and terminals to help retard corrosion.

⚠ CAUTION
DO NOT operate engine without cooling water being supplied to seawater pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

7. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
8. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
9. Check steering system, shift and throttle controls for proper operation.

INDEX

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ENGINE

Section 3A - 377 cid / 6.2L Engines

Table of Contents

Torque Specifications 3A-3
Special Tools 3A-5
Specifications 3A-6
General Specifications 3A-6
Engine Specifications 3A-7
General Information 3A-11
Repair Procedures 3A-11
Engine Identification 3A-11
Engine Rotation 3A-12
Description 3A-12
Crankshaft 3A-12
Piston and Connecting Rods 3A-12
Camshaft and Drive 3A-12
Cylinder Head 3A-13
Valve Train 3A-13
Intake Manifold 3A-13
Lubrication System 3A-13
Bearing Failures 3A-14
Piston Failures 3A-16
Pre-Ignition 3A-16
Detonation 3A-17
Engine Mounts 3A-18
Engine Mounts (Continued) 3A-19
Rocker Arm Cover 3A-20
Removal 3A-20
Installation 3A-20
Intake Manifold 3A-21
Removal 3A-21
Cleaning and Inspection 3A-21
Installation 3A-22
Rocker Arm / Push Rod 3A-23
Removal 3A-23
Cleaning and Inspection 3A-23
Installation 3A-23
Valve Adjustment 3A-24
Engine Stopped 3A-24
Engine Operating 3A-25
Hydraulic Valve Lifters 3A-26
Locating Noisy Lifters 3A-26
Removal 3A-27
Cleaning and Inspection 3A-28
Installation 3A-28
Valve Stem Oil Seal / Valve Spring 3A-29
Removal - Head Installed 3A-29
Valve Assembly (Exploded View) 3A-30
Installation - Head Installed 3A-30
Cylinder Head 3A-31
Removal 3A-31
Cleaning and Inspection 3A-32
Installation 3A-32
Cylinder Head and Valve Conditioning . . 3A-33
Disassembly 3A-33
Cleaning and Inspection 3A-34
Valve Guide Bore Repair 3A-36
Valve Springs - Checking Tension 3A-36
Rocker Arm Stud Replacement 3A-37
Valve Seat Repair 3A-38
Valve Grinding 3A-39
Reassembly 3A-40
Crankcase Oil Dipstick Specifications . . . 3A-43
Oil Pan 3A-44
Removal 3A-44
Cleaning and Inspection 3A-44
Installation 3A-44
Oil Pump 3A-47
Exploded View 3A-47
Removal 3A-48
Disassembly 3A-49
Cleaning and Inspection 3A-49
Reassembly 3A-49
Installation 3A-50
Torsional Damper 3A-50
Removal 3A-50
Installation 3A-51
Crankcase Front Cover Oil Seal 3A-52
Oil Seal Replacement
(Without Removing Front Cover) 3A-52
Crankcase Front Cover 3A-53
Removal 3A-53
Cleaning and Inspection 3A-53
Installation 3A-53
Flywheel 3A-55
Removal 3A-55
Cleaning and Inspection 3A-55
Installation 3A-56
Rear Main Oil Seal 3A-57
Removal 3A-57
Cleaning and Inspection 3A-57
Installation 3A-57
Rear Main Oil Seal Retainer 3A-59
Removal 3A-59
Cleaning and Inspection 3A-59
Installation 3A-59
Main Bearings 3A-60
Inspection 3A-60
Checking Clearances 3A-60
Replacement 3A-62
Connecting Rod Bearings 3A-64
Inspection and Replacement 3A-64

Table of Contents (Continued)

Connecting Rod / Piston Assembly 3A-66
Removal 3A-66
Disassembly 3A-67
Cleaning and Inspection 3A-68
Reassembly 3A-69
Installation 3A-71
Crankshaft 3A-73
Removal 3A-73
Cleaning and Inspection 3A-76
Installation 3A-76
Timing Chain and Sprocket 3A-77
Removal 3A-77
Cleaning and Inspection 3A-78
Crankshaft Sprocket/Gear 3A-78
Removal 3A-78
Installation 3A-78
Checking Timing Chain Deflection . . . 3A-79
Camshaft 3A-79
Measuring Lobe Lift 3A-79
Removal 3A-80
Inspection 3A-80
Installation 3A-81
Camshaft Bearings 3A-81
Removal 3A-81
Cleaning and Inspection 3A-82
Installation 3A-82
Cylinder Block 3A-83
Cleaning and Inspection 3A-83
Oil Filter By-Pass Valve and Adaptor Assembly 3A-87
Removal 3A-88
Cleaning and Inspection 3A-88
Installation 3A-88

Torque Specifications

Description			lb-in.	lb-ft	Nm
Alternator Brace to Alternator			192		28
Alternator Brace to Engine				30	41
Alternator to Mounting Bracket				35	48
Alternator Mounting Bracket				30	41
Camshaft Sprocket Gear			216		24
Carburetor or Throttle Body			132		15
Connecting Rod Cap Nuts				36	49
Coupler-to-Flywheel (MCM)				35	48
Crankshaft Pulley				43	58
Crankcase Front Cover (Timing Chain/Gear Cover)			106		12
Cylinder Head Bolt 111	First Pass	Short Bolt Medium Bolt Long Bolt		22	30
	Final Pass (Angle Torque)	Short Bolt Medium Bolt Long Bolt	+ 55 Degrees + 65 Degrees + 75 Degrees		
Distributor Hold Down				18	25
Exhaust Manifold				33	45
Filter Adapter (5/16-18)				20	27
Flywheel				75	100
Flywheel Drive Plate (MIE)				35	48
Flywheel Housing to Block				30	41
Flywheel Housing Cover			80		9
Front Mount Bracket				30	41
Fuel Pump				25	34
Intake Manifold			133		15
Main Bearing Cap	First Pass			15	20
	Final Pass (Angle Torque)			+ 73 Degrees	
Main Bearing Cap (Optional - Without Angular Torque)				77	105

INDEX

Torque Specifications (Continued)

Description	lb-in.	lb-ft	Nm
Oil Baffle Nuts		25	34
Oil Filter Adapter Bolt		15	20
Oil Pan Drain Plug		15	20
Oil Pan Corner Nut		18	25
Oil Pan Nuts (5/16-18)	106		12
Oil Pump		65	88
Oil Pump Cover	80		9
Power Steering Pump Brace to Block		30	41
Power Steering Pump Bracket			
Rear Crankshaft Oil Seal Retainer Bolts and Nuts	106		12
Rear Mount (MCM)		40	54
Rear Mount (MIE)		50	68
Remote Oil Connector (1/2 in. x 13)		25	34
Remote Oil Filter Adapter Nut / Fitting		20	27
Rocker Arm Cover	106		12
Roller Lifter Restrictor Retainer Plate		18	25
Seawater Pump Brace		30	41
Seawater Pump Bracket			
Spark Plugs (New Cylinder Head)		22	30
Spark Plugs (All Others)		15	20
Starter Motor		50	50
Thermostat Housing		30	41
Torsional Damper		40	54
Transmission To Housing		50	68
Water Circulating Pump		33	45
Water Temperature Sender		20	27

INDEX

Special Tools

KENT-MOORE SPECIAL TOOLS	
Kent-Moore Special Tools 29784 Little Mack Roseville, MI 48066 Phone: 1-800-345-2233	
Description	**Part Number**
Valve Spring Compressor (Head on)	J5892
Valve Spring Compressor (Head off)	J8062
Valve Spring Tester	J8056
Valve Guide Cleaner	J8101
Valve Guide Reamer (Standard)	J7049
Valve Guide Reamer (.015 in. oversize)	J5830-02
Rocker Arm Stud Remover	J5802-01
Rocker Arm Stud Installer	J6880
Stud Bore Reamer (.003 in. oversize)	J5715
Stud Bore Reamer (.013 in. oversize)	J6036
Carbon Remover Brush	J8089
Piston Pin Tool	J24086-B
Piston Ring Groove Cleaner	J3936-03
Piston Ring Compressor	J8037
Connecting Rod Guide Tool (3/8 -24)	J5239
Oil Pump Suction Pipe Installer	J21882
Camshaft Bearing Installer/Remover Tool	J6098-01
Ball Socket Adapter	J8520-1
Torsional Damper Remover and Installer	J23523-E
Crankcase Front Cover Seal Installer	J35468
Crankshaft Gear and Sprocket Puller	J5825-A
Crankshaft Gear and Sprocket Installer	J5590
Air Adapter	J23590
Main Bearing Remover and Installer	J8080
Rear Main Seal Installer	J26817-A

Specifications

General Specifications

Engine Model	6.2L MPI
Displacement	377 cid (6.2 l)
Bore	4.00 (101.6)
Stroke	3.750 in. (95.25 mm)
Firing Order	1-8-4-3-6-5-7-2
Compression Ratio	9.0:1
Heads	Cast Iron
Intake Manifold	Aluminum (MPI Models)
Block	Cast Iron (2 Bolt Main Bearing Caps)
Rods	Forged Steel
Crankshaft	Forged Steel
Pistons	Cast Aluminum
Camshaft	Steel

Engine Specifications

NOTICE
Unit Of Measurement: Inches (Millimeters)

CYLINDER BORE

Engine			377 cid (6.2L)
Diameter			4.00-4.001 (101.618-101.643)
Out of Round		Production	0.001 (0.025) Max
		Service	0.002 (0.05) Max
Taper	Production	Thrust Side	0.0005 (0.012) Max
		Relief Side	0.001 (0.025) Max
	Service Limit		0.001 (0.025) Over Production

PISTON CLEARANCE

Production	0.0007-0.002 (0.018-0.053) Max
Service	0.0007-0.0026 (0.018-0.068) Max

PISTON RING: COMPRESSION

Groove Clearance	Production	Top	0.0012-0.0027 (0.030-0.070)
		2nd	0.0015-0.003 (0.040-0.080)
	Service	Top	0.0012-0.0035 (0.030-0.090)
		2nd	0.0015-0.004 (0.040-0.100)
Gap	Production	Top	0.009-0.020 (0.25-0.51)
		2nd	0.010-0.020 (0.46-0.66)
	Service	Top	0.012-0.027 (0.30-0.68)
		2nd	0.020-0.037 (0.51-0.94)

PISTON RING: OIL

Groove Clearance	Production	0.002-0.006 (0.051-0.17)
	Service	0.002-0.0076 (0.051-0.195)
Gap	Production	0.009-0.029 (0.25-0.76)
	Service	0.011-0.032 (0.28-0.81)

INDEX

PISTON PIN

Diameter		0.9269-0.9270 (23.545-23.548)
Clearance	Production	0.0005-0.0009 (0.013-0.023)
	Service Limit	0.0005-0.00098 (0.013-0.025) Max
Fit in Rod		0.00082-0.00157 (0.021-0.040) Interference

CRANKSHAFT

Engine			**377 cid (6.2L)**
Main Journal	Diameter	No.1	2.4483-2.4492 (62.189-62.212)
Main Journal	Diameter	No. 2, 3, 4	2.4480-2.4490 (62.181-62.207)
		No.5	2.4479-2.4490 (62.177-62.207)
	Taper	Production	0.00019 (0.005) Max
		Service	0.001 (0.02) Max
	Out of Round	Production	0.00019 (0.005) Max
		Service	0.00098 (0.025) Max
Main Bearing Clearance	Production	No.1	0.0007-0.0022 (0.018-0.053)
		No. 2, 3, 4	0.00086-0.0024 (0.022-0.061)
		No.5	0.00098-0.0027 (0.025-0.069)
	Service	No.1	0.00098-0.002 (0.025-0.051)
		No. 2, 3, 4	0.00098-0.0025 (0.025-0.064)
		No.5	0.00149-0.0029 (0.038-0.076)
Crankshaft End Play			0.0019-0.0078 (0.05-0.20)
Connecting Rod Journal	Diameter		2.0977-2.0997 (53.284–53.334)
	Taper	Production	0.00027 (0.007) Max
		Service	0.00098 (0.025) Max
	Out of Round	Production	0.00027 (0.007) Max
		Service	0.00098 (0.025) Max
Rod Bearing Clearance		Production	0.00129-0.00346 (0.033-0.088)
		Service	0.00098-0.0029 (0.025-0.076)
Rod Side Clearance			0.0059-0.0240 (0.15-0.61)
Crankshaft Runout			0.0019-0.0078 (0.05-0.20)

INDEX

VALVE SYSTEM

Engine			377 CID (6.2L)
Lifter Type			Roller Hydraulic
Rocker Arm Ratio			1.50 to 1
Valve Lift		Intake	0.3114-.3153 (.79-.80)
		Exhaust	0.3160-.3200 (.80-.81)
Valve Lash (Intake and Exhaust)			1 Turn Down from Zero Lash
Face Angle		Intake	45°
		Exhaust	45°
Seat Angle (Intake & Exhaust)			46°
Seat Runout (Intake & Exhaust)			0.0019 (0.05) Max
Seat Width		Intake	0.0401-0.0649 (1.02-1.65)
		Exhaust	0.059-0.100 (1.50-2.56)
Stem Clearance	Production	Intake	0.00098-0.0027 (0.025-0.069)
		Exhaust	0.00098-0.0027 (0.025-0.069)
	Service	Intake	0.00098-0.0037 (0.025-0.094)
		Exhaust	0.0010-0.0076 (0.025-0.194)
Stem Diameter		Intake	.341 (8.66)
		Exhaust	.341 (8.66)
Valve Diameter		Intake	1.94 (49.28)
		Exhaust	1.50 (38.1)
Valve Margin After Surfacing - Intake and Exhaust			0.031 (0.79) Minimum

VALVE SPRING

Engine			377 CID (6.2L)
Valve Spring	Free Length		2.019 (51.3)
	Pressure	Valve Closed	76-84 Lb. (338-374 N) at 1.7 (43.2)
		Valve Open	187-203 Lb. (832-903 N) at 1.27 (32.3)
	Installed Height	Intake	1.68-1.70 (42.92-43.43)
		Exhaust	1.68-1.70 (42.92-43.43)
	Free Length		2.019 (51.3)
	Approximate Number of Coils		4

CAMSHAFT AND DRIVE

Engine	377 cid (6.2L)
Journal Diameter	1.8677-1.8661 (47.440-47.490)
Journal Out Of Round	0.001 (0.025) Maximum
Camshaft Runout	0.0026 (0.06) Maximum
Timing Chain Deflection	0.43 (11) Maximum

FLYWHEEL

Engine	377 cid (6.2L)
Runout	0.008 (0.203) Maximum

CYLINDER HEAD

Engine	377 cid (6.2L)
Surface Flatness (At Exhaust Manifold Deck)	0.0019 (0.05)
Surface Flatness (At Engine Block Deck)	0.0039 (0.10)
Surface Flatness (At Intake Manifold Deck)	0.0039 (0.10)

General Information

Repair Procedures

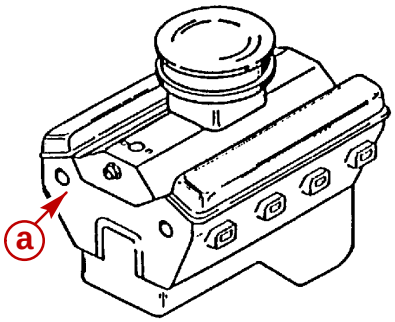
Some of the repairs in this section must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

Lubricate all moving parts (during reassembly) with engine oil. Apply Quicksilver Perfect Seal on threads of and under heads of cylinder head bolts, and on threads of all cylinder block external bolts, screws and studs.

Engine Identification

The Mercury MerCruiser model can be determined by looking at the last two letters of the engine code stamped into the cylinder block. This code number is stamped on all Mercury MerCruiser power packages and replacement partial engines, but not replacement cylinder block assemblies.

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models.



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a - Location Of Engine Code

Following is a list of engines and their respective code letters.

MCM (Sterndrive)	Code
MX 6.2 MPI	MHA

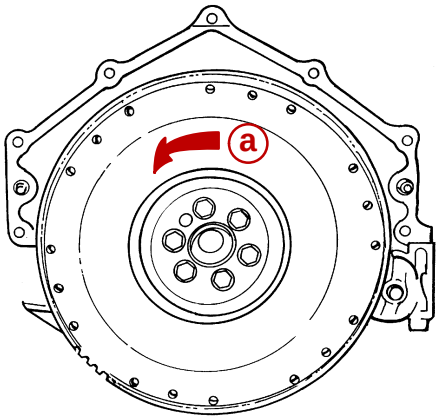
MIE (Ski and Inboard)	Code
MX 6.2 Black Scorpion	MHA
MX 6.2 MPI	MKA

Engine Rotation

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation.

When ordering replacement engines, short blocks or parts for engines, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



72001

a - Left-Hand Rotation (CCW) - All Sterndrive Engines, MIE Inboard LH (Standard) Rotation

Description

Crankshaft

The crankshaft is supported in the block by five insert type bearings. Crankshaft end thrust is controlled by flanges on the No. 5 bearing. A torsional damper on the forward end of the crankshaft serves to help dampen any engine torsional vibration.

Piston and Connecting Rods

Piston pins are offset slightly toward the thrust side of the pistons to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins have a floating fit in the piston and a press fit in the connecting rod (to hold them in place).

Connecting rods are made of forged steel and are connected to the crankshaft through insert type bearings.

Camshaft and Drive

Engines with roller lifters have camshafts made of billet steel. All camshafts are driven at one-half crankshaft speed by a timing chain and sprockets, or by timing gears. The camshafts are supported by five main bearings that are pressed into the block. A helical gear on the aft end of the camshaft drives the distributor and oil pump.

⚠ CAUTION

Avoid rapid and severe camshaft and fuel pump push rod wear that could result in engine damage. Always use the fuel pump push rod specified for use with the cast iron or steel camshaft in your engine.

Engines with steel camshaft and roller lifters have eight restrictors held in place by a retaining plate to keep the hydraulic valve lifters from rotating so that they follow the cam lobes precisely.

INDEX

Cylinder Head

The cylinder heads are made of cast iron and have individual intake and exhaust ports for each cylinder.

Stainless steel or graphite composition head gaskets are used to retard corrosion.

Valve Train

The valves and valve springs are heavy-duty to withstand the high engine speeds encountered. Valve tips have been hardened to extend valve life. Exhaust valve rotators are used on some engines to help extend valve life.

Hydraulic valve lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods that actuate the valves through the rocker arm.

In addition to transmitting thrust of the cam lobes, the hydraulic lifters also serve to remove any clearance (lash) from the valve train to keep all parts in constant contact.

The valve lifters also are used to lubricate the valve train bearing surfaces.

Intake Manifold

The multi-port injection manifold is a tunnel ram design with the injectors mounted directly above the intake ports in cylinder head.

Lubrication System

The engine lubrication system is a force-feed type. Oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearings and valve lifters, and is supplied under controlled volume to the push rods and rocker arms. All other moving parts are lubricated by gravity flow or splash.

A positive displacement gear-type oil pump is mounted on the rear main bearing cap and is driven by an extension shaft from the distributor (which is driven by the camshaft). Oil from the bottom of the pump in the rear of the oil pan is drawn into the oil pump through an oil pickup screen and pipe assembly.

If the screen should become clogged, a relief valve in the screen will open and continue to allow oil to be drawn into the system. Once the oil reaches the pump, the pump forces the oil through the lubrication system. A spring-loaded relief valve in the pump limits the maximum pump output pressure.

After leaving the pump, the pressurized oil flows through a full-flow oil filter. On engines with an engine oil cooler, the oil also flows through the cooler before returning to the block. A bypass valve allows oil to bypass the filter and oil cooler should they become restricted.

Some of the oil, after leaving the oil cooler and/or filter, is routed to the No. 5 crankshaft main bearing. The remainder of the oil is routed to the main oil gallery, which is located directly above the camshaft and runs the entire length of the block. From the main oil gallery, the oil is routed through individual oil passages to an annular groove in each camshaft bearing bore. Some of the oil is then used to lubricate camshaft bearings. The remainder of the oil is routed to the valve lifter oil galleries and No. 1, 2, 3, and 4 crankshaft main bearings by means of individual oil passages which intersect with the annular grooves.

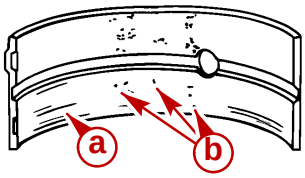
The camshaft bearings have holes which align with the oil passages or annular grooves in the block and allow oil to flow between the bearings and the camshaft journals. The oil that is forced out the front end of the No. 1 camshaft bearing drains down onto the camshaft drive and keeps it lubricated.

The oil that reaches the crankshaft main bearings is forced through a hole in the upper half of each bearing and flows between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings through grooves in the upper half of the crankshaft main bearings and oil passages in the crankshaft. Oil that is forced out the ends of the connecting rod bearings and crankshaft main bearings and splashes onto the camshaft, cylinder walls, pistons and piston pins, keeping them lubricated. Oil is forced out the front end of the No. 1 crankshaft main bearing to assist in lubricating the camshaft drive. A baffle plate, mounted on the bottom of the main bearings or in the oil pan, prevents oil thrown from the crankshaft and connecting rods from aerating the oil in the oil pan.

Oil that reaches the valve lifter oil galleries is forced into each leave valve lifter through holes in the side of the lifter. From here, the oil is forced through the metering valve in each of the lifters (which controls the volume of oil flow) and then up through the push rods to the rocker arms. A hole in each rocker arm push rod seat allows the oil to pass through the rocker arm and lubricate the valve train bearing surfaces. After lubricating the valve train, oil drains back to the oil pan through oil return holes in the cylinder head and block.

The distributor shaft and gear is lubricated by the oil flowing through the right valve lifter oil gallery.

Bearing Failures



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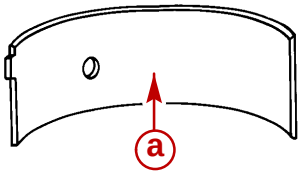
Scratched By Dirt

a - Scratches
b - Dirt Imbedded In Bearing Material



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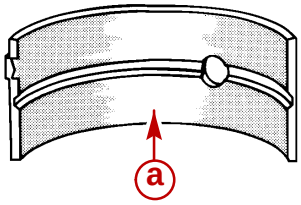
Tapered Journal

a - Overlay Gone From Entire Surface



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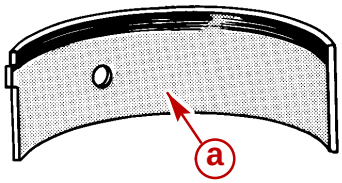
Lack Of Oil

a - Overlay Worn Off



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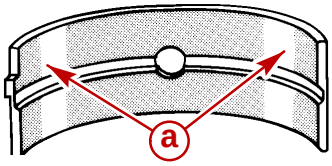
Radius Ride

a - Worn Area



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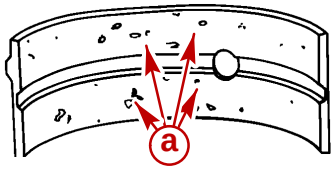
Improper Seating

a - Bright Or Polished Sections



70436

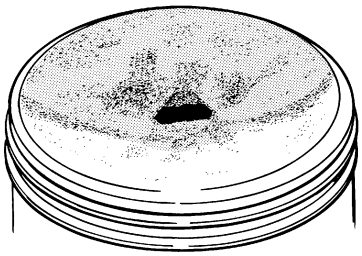
Fatigue Failure

a - Craters or Pockets

Piston Failures

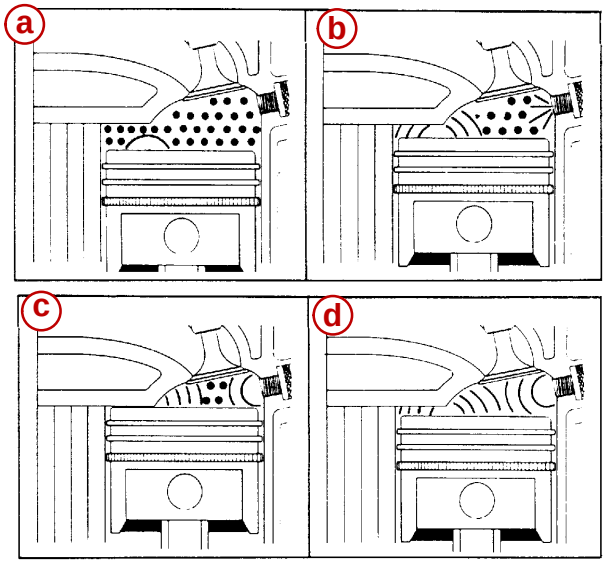
Pre-Ignition

Pre-ignition is abnormal fuel ignition caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion on the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.



72424

Pre-Ignition Damage



72314

a - Ignited By Hot Deposits
b - Regular Ignition Spark
c - Ignites Remaining Fuel
d - Flame Front Collide

PRE-IGNITION CAUSES

1. Hot spots in the combustion chamber from glowing deposits (due to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material that could serve as a source for pre-ignition problems.

NOTE: *Engine failures that result from the foregoing conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.*

INDEX

Detonation

Detonation, commonly called “fuel knock,” “spark knock” or “carbon knock,” is abnormal combustion of the fuel causing the fuel to explode violently. The explosion causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.

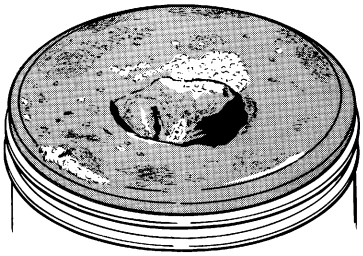
DETONATION CAUSES

1. Use of low octane gasoline or neglecting engine maintenance.

IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

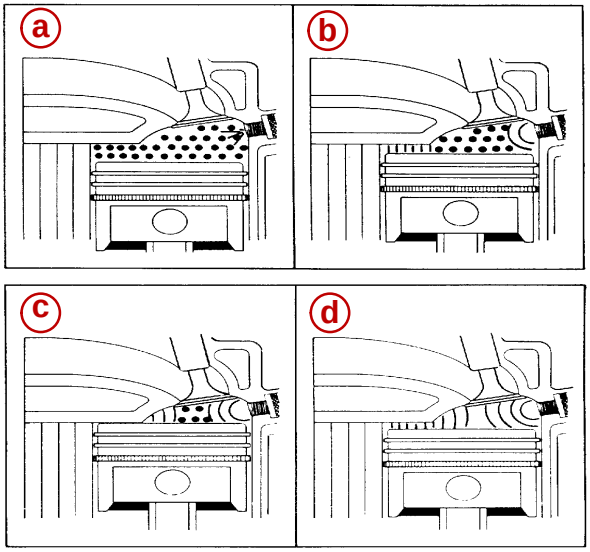
2. Over-advanced ignition timing.
3. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
4. Cross-firing spark plugs.
5. Excess accumulation of deposits on piston and/or combustion chamber that result in higher compression ratio.
6. Inadequate cooling of engine due to deterioration of cooling system.

NOTE: *Engine failures, that result from the foregoing conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.*



72425

Detonation Damage

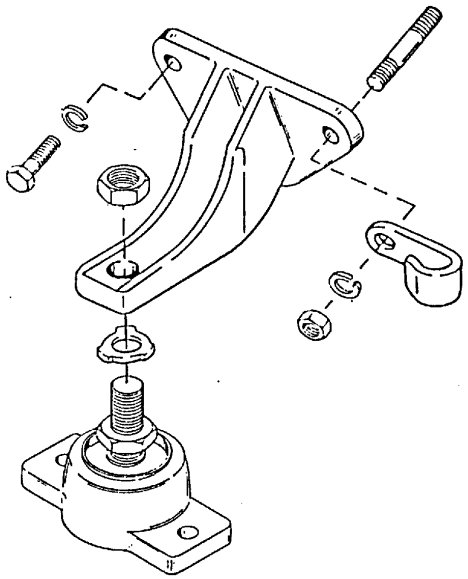


72315

a - Spark Occurs
b - Combustion Begins
c - Combustion Continues
d - Detonation Occurs

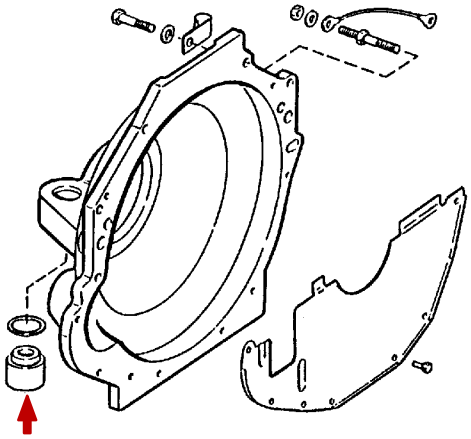
INDEX

Engine Mounts



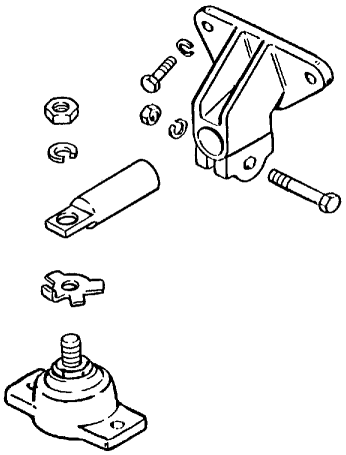
72317

Front Mount - All MCM (Sterndrive) Models



72318

Rear Mount / Flywheel Housing - All MCM (Sterndrive) Models

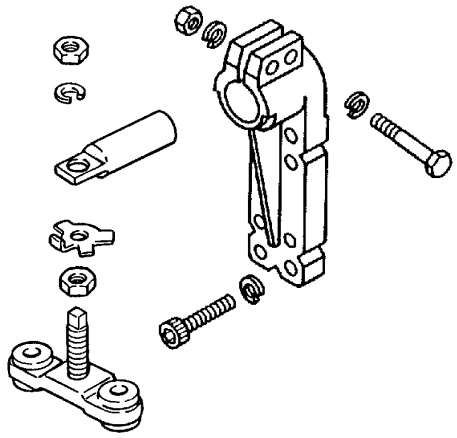


72319

Front Mount Assembly - All MIE Models

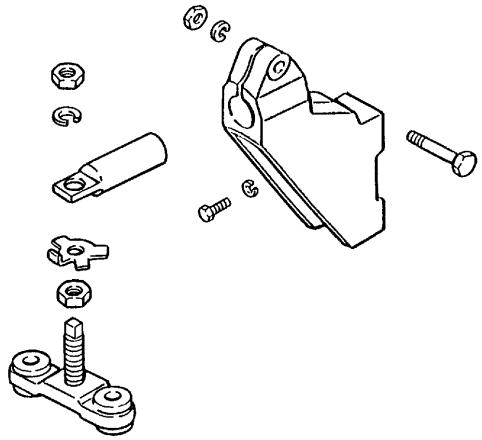
INDEX

Engine Mounts (Continued)



73055

Rear Mount Assembly - Most MIE Models



73056

Rear Mount Assembly - MIE Models with Velvet Drive In-Line Transmission

Rocker Arm Cover

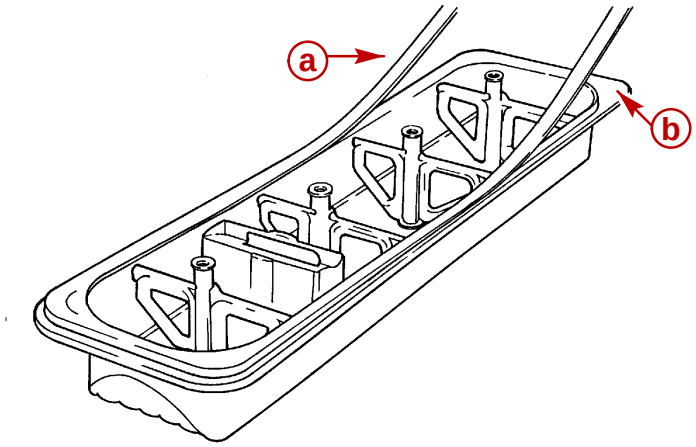
Removal

NOTE: *It may be necessary to remove exhaust manifold before removing rocker arm cover. Refer to SECTION 7B of Service Manual Number 24 for exhaust manifold removal.*

1. Disconnect crankcase ventilation hoses.
2. Remove any items that interfere with the removal of rocker arm covers.
3. Remove rocker arm cover.

Installation

1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Place new rocker arm cover gasket in position.



72324

a - Rocker Arm Cover Gasket
b - Sealing Surface

3. Install rocker arm cover. Torque screws to 90 lb-in. (10 Nm).
4. Reinstall any items that were removed.
5. Connect crankcase ventilation hoses.
6. Start engine and check for oil leaks.

Intake Manifold

Removal

1. Drain engine cooling system.
2. Disconnect hoses from thermostat housing.
3. Disconnect electrical leads interfering with removal.
4. Disconnect crankcase ventilation hoses from rocker arm covers.
5. Disconnect throttle cable.
6. Disconnect fuel line from fuel rail.
7. Remove distributor cap and mark position of rotor on distributor housing. Also mark position of distributor housing on intake manifold.
8. Remove distributor.

IMPORTANT: Do not crank engine over after distributor has been removed.

9. Remove other ignition components.
10. Remove oil pressure sending unit.
11. Disconnect any items that interfere with removal of manifold.
12. Remove intake manifold bolts.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block, in next step. Use extreme care to prevent damage to sealing surfaces.

13. Remove intake manifold and throttle body / fuel rail assembly.

NOTE: *If intake manifold requires replacement, transfer all remaining parts to new manifold.*

Cleaning and Inspection

1. Clean gasket material from all mating surfaces.

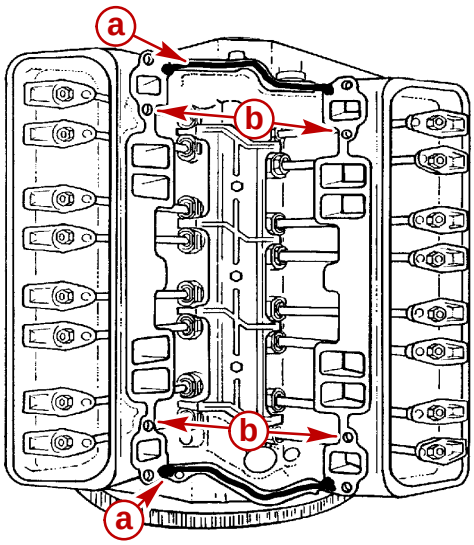
IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or intake ports.

2. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks and deep scratches or leaks may result.
3. Inspect intake passages for varnish buildup and other foreign material. Clean as necessary.

Installation

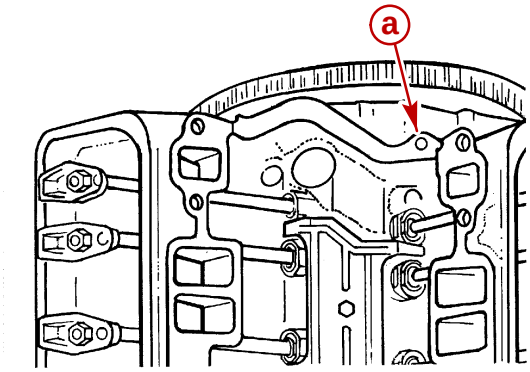
IMPORTANT: DO NOT get Quicksilver RTV Sealer into oil sending unit hole at rear of engine.

1. Apply a 3/16 in. (5 mm) wide bead of Quicksilver RTV Sealer to engine block as shown. Extend sealer 1/2 in. (13 mm) up on intake gaskets.
2. Apply Loctite Pipe Thread Sealant to the threads of the four inner manifold bolts.



72325

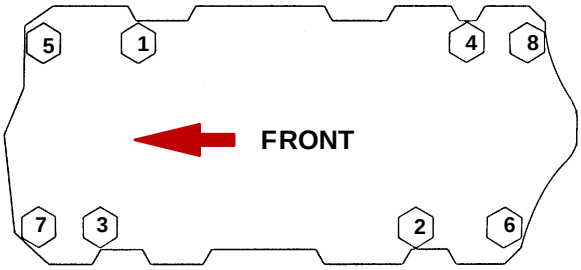
a - 3/16 Bead Of RTV Sealer
b - Inner Manifold Bolts With Loctite Pipe Thread Sealant



72326

a - Oil Sending Unit Hole

3. Carefully install manifold assembly and torque bolts to 18 lb-ft (24 Nm) in sequence as shown.



72878

4. Connect all electrical leads.
5. Connect hoses to thermostat housing.

INDEX

6. Install fuel line.
7. Connect crankcase ventilation hose(s).
8. Install distributor. Position rotor and housing to align with marks made during removal, then install distributor cap.
9. Install other ignition components and reconnect wires.
10. Coat threads of oil pressure sending unit with Quicksilver Perfect Seal and install.
11. Connect any items that were disconnected.
12. Start engine.
13. Adjust ignition timing.
14. Check hose connections, gaskets and seals for leaks.
15. Inspect fuel line connections for fuel leaks.

Rocker Arm / Push Rod

Removal

NOTE: *When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC before removing rocker arms. When servicing all rocker arms, bring No. 1 piston up to TDC before removing rocker arms.*

1. Remove rocker arm covers.
2. Remove rocker arm assemblies and push rods.

IMPORTANT: Place rocker arm assemblies and push rods in a rack for reassembly in their original locations.

Cleaning and Inspection

1. Clean parts with solvent and dry with compressed air.
2. Inspect all contact surfaces for wear. Replace all damaged parts.

Installation

IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rocker arm balls with engine oil.

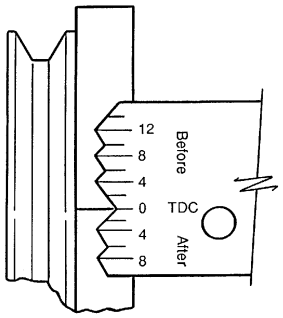
1. Install push rods in their original locations. Ensure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts in their original locations.
3. Adjust valves.

Valve Adjustment

Engine Stopped

With valve cover removed, adjust valves when lifter is on low part of camshaft lobe.

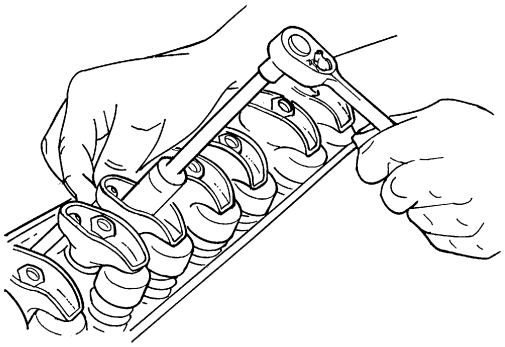
1. Crank engine with starter or turn over in normal direction of rotation until mark on torsional damper lines up with center “0” mark on timing tab. Ensure engine is in No. 1 firing position by placing fingers on No. 1 valve as mark on torsional damper comes near “0” mark on timing mark. If valves move as mark comes up to timing tab, engine is in No. 6 firing position and should be turned over one more time to reach No. 1 position.



72328

2. Adjust the following valves:

Exhaust	Intake
1-3-4-8	1-2-5-7



72300

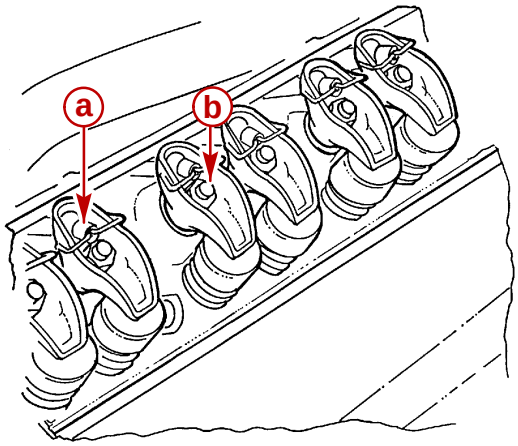
3. Hydraulic lifters can be adjusted by tightening adjustment nut an additional one turn (360 degrees). No other adjustment is required.
4. Crank engine one revolution until pointer “0” mark and torsional damper mark are again in alignment. This is No.6 firing position. With engine in this position, the following valves may be adjusted as previously outlined.

Exhaust	Intake
2-5-6-7	3-4-6-8

Engine Operating

Following procedure is performed with engine operating:

1. Check engine for normal operating temperature.
2. Remove rocker arm covers and install rocker stoppers as shown.



72301

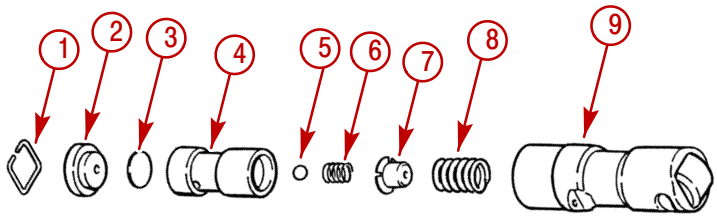
a - Rocker Stoppers (91-66273)
b - Rocker Arm Nuts

3. With engine operating at idle, loosen one rocker arm nut until rocker arm starts to clatter.
4. Turn rocker arm nut down until clatter just stops. This is zero lash position.

IMPORTANT: The following one-turn preload adjustment must be done slowly to allow the lifter to adjust itself. This will prevent the valves from hitting the pistons and causing internal damage and/or bent push rods.

5. Turn nut down 1/4 additional turn (90 degrees) and pause 10 seconds until engine runs smoothly. Repeat until nut has been turned down one turn (360 degrees) from the zero lash position.
6. Repeat Steps 2, 3, 4 to adjust other valves.
7. Remove rocker stoppers after all valves are adjusted.
8. Install rocker arm covers; torque screws to 106 lb-in. (12 Nm).
9. Check for leaks.

Hydraulic Valve Lifters



72031

Roller Lifter

1 - Push Rod Seat Retainer
2 - Push Rod Seat
3 - Metering Valve
4 - Plunger
5 - Check Ball
6 - Check Ball Spring
7 - Check Ball Retainer
8 - Plunger Spring
9 - Lifter Body

Hydraulic valve lifters require little attention. Normally, readjustments are not necessary.

Locating Noisy Lifters

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2 m) in length. Place one end of hose near end of each intake and exhaust valve and other end of hose to the ear. In this manner, sound is localized making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

1. Hard rapping noise - usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit causing abnormal stickiness.
   b. Galling or “pickup” between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise. Probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train. Probable causes are:
   a. Insufficient oil supply.
   b. Improper adjustment.

4. Intermittent clicking. Probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball may be out of round or have a flat spot.
   c. Improper adjustment.

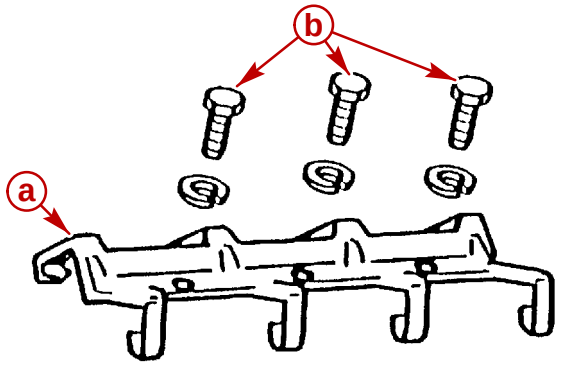
In most cases where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc., is shown to exist in one unit, it probably exists in all the units. Thus it would only be a matter of time before all lifters caused trouble.

Removal

IMPORTANT: Keep push rod and hydraulic valve lifter from each valve together as a matched set and mark them so they can be reinstalled in the same location later.

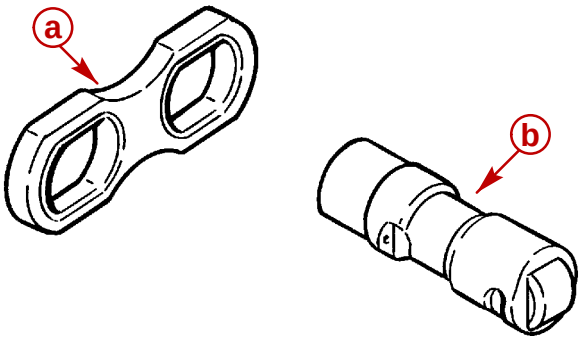
1. Remove rocker arm covers.
2. Remove intake manifold.
3. Remove lifter restrictor retainer on roller lifter models.
4. Remove rocker arm assemblies and push rods.

NOTE: *Engines with roller lifters have additional valve train components shown below.*



72329

a - Lifter Restrictor Retainer
b - Fasteners



72340

a - Roller Lifter Restrictor
b - Roller Lifter

5. Remove lifter restrictors and lifters.

Cleaning and Inspection

1. Thoroughly clean all parts in cleaning solvent and inspect them carefully. If any parts are damaged or worn, entire lifter assembly should be replaced.
2. If outer lifter body wall is scuffed or worn, inspect cylinder block lifter bore.
3. If roller of lifter is scuffed or worn, inspect camshaft lobe.
4. If push rod seat is scuffed or worn, inspect push rod.

Installation

IMPORTANT: It is recommended that the engine oil be changed and a new oil filter be installed whenever servicing valve lifters or camshaft.

IMPORTANT: Before installing lifters/rollers, coat the bottom of the lifter/roller with engine oil. If new lifters or a new camshaft have been installed, an additive containing EP lube (such as General Motors Cam and Lifter Prelube or equivalent) should be poured over camshaft lobes before installing lifters.

IMPORTANT: Before installation, coat entire valve lifter with engine oil.

IMPORTANT: DO NOT install used valve lifters if a new camshaft has been installed.

1. Install roller lifters and components.
2. Torque roller lifter restrictor retainer plate fasteners to 18 lb-ft (25 Nm).
3. Install intake manifold.
4. Install and adjust valve mechanism.
5. Install rocker arm cover.
6. Start engine and check for leaks.

Valve Stem Oil Seal / Valve Spring

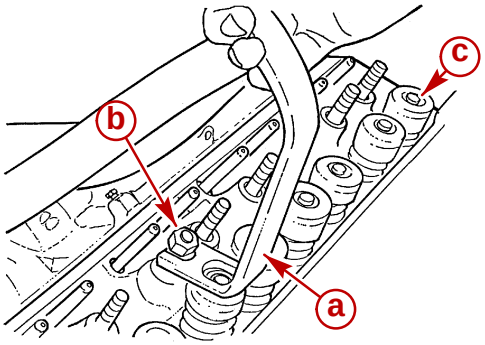
Removal - Head Installed

1. Remove rocker arm cover.
2. Remove spark plug of affected cylinder.
3. Remove rocker arm assembly.
4. Install air line adaptor tool (J-23590) in spark plug hole and apply compressed air to hold valves in place.

NOTE: *If compressed air is not available, piston may be brought up to TDC and used to keep valves from falling out of valve guides.*

IMPORTANT: Do not turn crankshaft while valve springs, retainers, and locks are removed or valves will fall into cylinder.

5. Using valve spring compressor as shown, compress valve spring and remove valve locks.



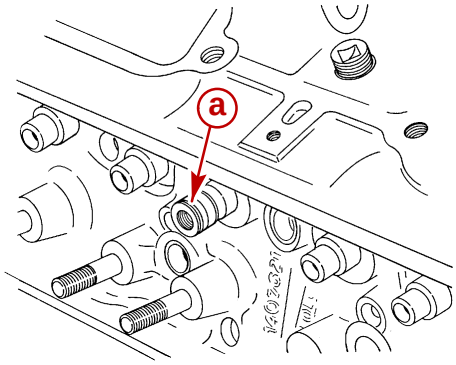
72306

a - Valve Spring Compressor (J5892)
b - Rocker Arm Nut
c - Valve Locks

6. Slowly release valve spring compressor.
7. Remove cap, shield, and valve spring.

IMPORTANT: Keep air pressure in cylinder while springs, caps, and valve locks are removed or valves will fall into cylinder.

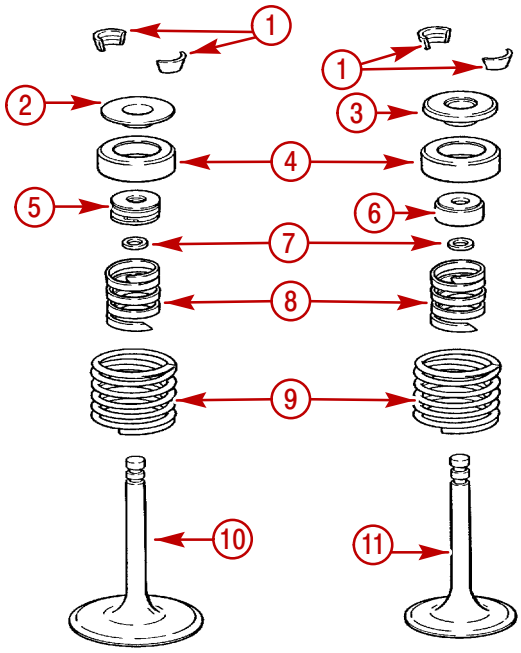
8. Remove seals from valve stems and valve guide.



72330

a - Valve Guide Seal

Valve Assembly (Exploded View)



72331

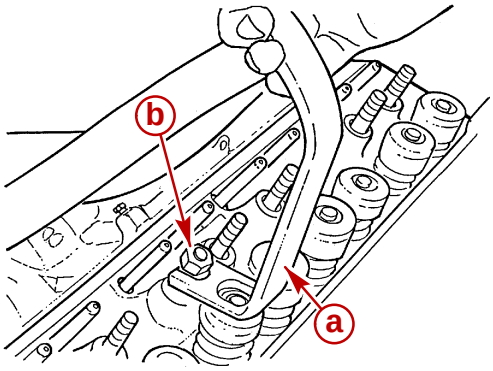
Intake **Exhaust**

1 - Valve Locks
2 - Retainer
3 - Rotator
4 - Cap
5 - Valve Guide Oil Seal
6 - Oil Shield
7 - Valve Stem Oil Seal
8 - Inner Spring
9 - Outer Spring
10 - Intake Valve
11 - Exhaust Valve

Installation - Head Installed

1. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.
2. Set valve spring (with damper installed) and shield in place.
3. Place cap on intake valve and/or rotator on exhaust valve.
4. While compressing valve spring with valve spring compressor, install oil seal in lower groove of valve stem, making sure seal is not twisted. A light coating of oil will help prevent twisting.

5. Install valve locks (Quicksilver Needle Bearing Assembly Lubricant may be used to hold them in place) and slowly release tool, making sure locks seat properly in upper grooves of valve stem.



72306

a - Valve Spring Compressor (J-5892)
b - Rocker Arm Nut

6. Install push rods and rocker arm assemblies.
7. Adjust valves as outlined under “Valve Adjustment - Engine Stopped.”
8. Install rocker arm cover.
9. Torque to 90 lb-in. (10 Nm).
10. Install spark plug.
11. Torque to 15 lb-ft (20 Nm).

Cylinder Head

Removal

1. Drain engine cooling system.
2. Remove exhaust manifolds.
3. Remove intake manifold.
4. Remove rocker arm covers.
5. Remove rocker arm assemblies and push rods (keep in order for reassembly in their original locations).
6. Remove any components attached to front or rear of cylinder head.
7. Remove spark plugs.
8. Remove head bolts.

⚠ CAUTION

The head gasket may be holding cylinder head to block. Use care when prying off cylinder heads. DO NOT damage gasket surfaces. DO NOT drop cylinder heads.

9. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.

Cleaning and Inspection

1. Clean gasket material and sealer from engine block and cylinder heads.
2. Inspect sealing surfaces for deep nicks and scratches.
3. Inspect for corrosion around cooling passages.
4. Clean head bolt threads and engine block bolt hole threads, making sure no dirt, old oil or coolant remain.

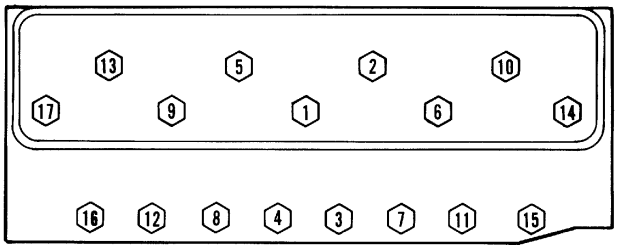
Installation

⚠ CAUTION

When using ribbed stainless steel head gaskets, apply a thin coating of Quicksilver Perfect Seal to both sides of gasket. Too much sealer may hold gasket away from head or block causing leakage. DO NOT use sealer on graphite composition head gaskets.

1. Place head gasket in position over dowel pins.
2. Carefully set cylinder head in place over dowel pins.
3. Coat threads of head bolts with Quicksilver Perfect Seal and install finger-tight.
4. Torque cylinder heads in two steps. First pass, torque all bolts to 22 lb-ft (30 Nm). Second pass is an angle torque sequence as follows:

First Pass	Short Bolt Medium Bolt Long Bolt	22 lb-ft (30 Nm)
Second Pass (Angle Torque)	Short Bolt	+ 55 Degrees
	Medium Bolt	+ 65 Degrees
	Long Bolt	+ 75 Degrees



72332

5. Install push rods and rocker arm assemblies in their original positions.
6. On roller cam engines, install lifter restrictors and retainer.
7. Adjust valves as outlined under “Valve Adjustment - Engine Stopped.”
8. Install as outlined:
   a. Intake manifold.
   b. Rocker arm covers.
   c. Exhaust manifolds.
   d. Spark plugs.
   e. Any components removed from front or rear of cylinder heads.

INDEX

9. Follow procedures in SECTION 6A or 6B of Service Manual Number 24:

Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see SECTION 6A).

Closed Cooled Models: Refill closed cooling section (see SECTION 6B), and provide adequate water supply to seawater pickup.

⚠ CAUTION

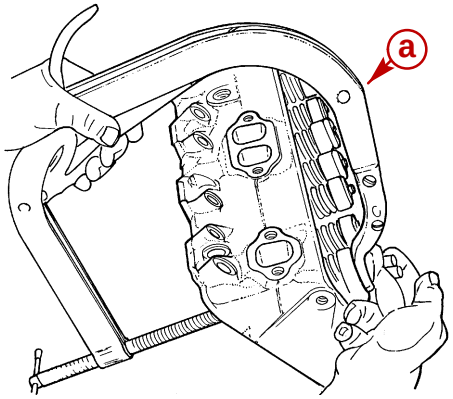
Ensure that cooling water supply is available before starting the engine.

10. Start engine.
11. Set timing.
12. Set idle speed.
13. Check for leaks.

Cylinder Head and Valve Conditioning

Disassembly

1. Using valve spring compressor, compress valve spring and remove valve locks. Slowly release tool.



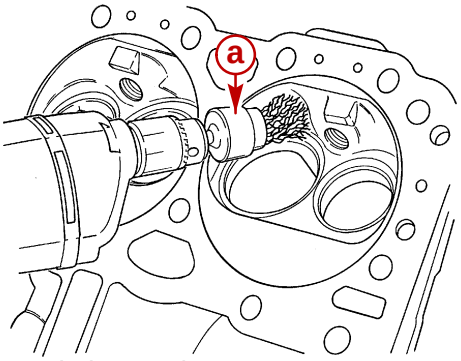
72333

a - Valve Spring Compressor (J-8062)

2. Remove all valve components.
3. Remove valves from cylinder head and place in a rack, for reassembly in their original locations.

Cleaning and Inspection

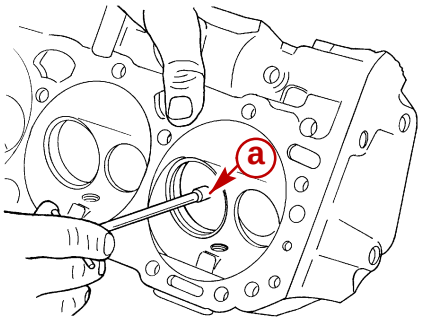
1. Clean push rods and rocker arm assemblies.
2. Clean carbon from valves using a wire wheel.
3. Clean gasket material from cylinder head mating surfaces.
4. Clean all carbon from combustion chambers and valve ports using carbon remover brush.



72334

a - Carbon Remover Brush (J-8089)

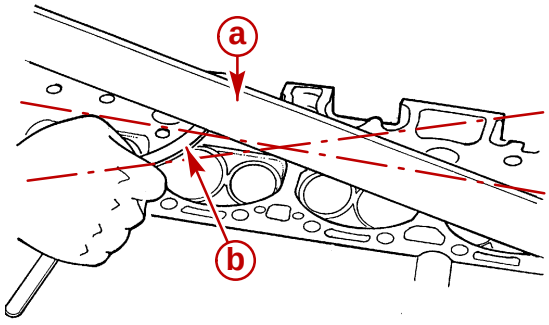
5. Thoroughly clean valve guides with valve guide cleaner.



72335

a - Valve Guide Cleaner (J-8101)

6. Inspect cylinder heads for cracks in exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats). Replace heads if any cracks are found.
7. Inspect cylinder head gasket surface for burrs, nicks, erosion or other damage.
8. Check flatness of cylinder head gasket surface, using a machinist's straight edge and feeler gauges as shown. Refer to "Specifications." Take measurements diagonally across head both ways) and straight down center of head.



72307

a - Straight Edge
b - Feeler Gauge

INDEX

IMPORTANT: Cylinder head surfaces should be resurfaced if warped more than specified to provide proper alignment.

9. Inspect valves for burned heads, cracked faces or damaged stems.

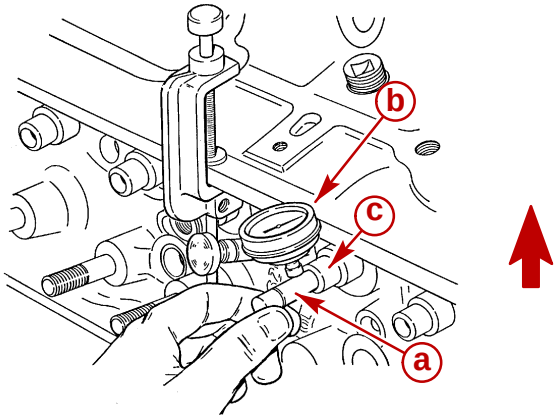
IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky valves.

10. Measure valve stem clearance as follows:

    a. Attach a dial indicator to cylinder head, positioning it against the valve stem and close to the valve guide.

    b. Holding valve head off seat about 1/16 in. (2 mm), move valve stem back and forth in direction shown. Compare stem clearance with specifications.

    c. If clearance exceeds specifications, it will be necessary to ream valve guides for oversized valves. Refer to “Valve Guide Bore Repair.”



72336

a - Valve Stem
b - Dial Indicator
c - Valve Guide

Valve Guide Bore Repair

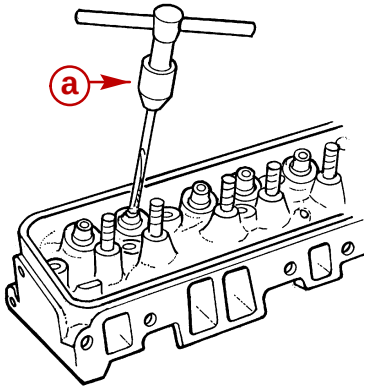
IMPORTANT: Measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

If .015 in. oversize valves are required, ream valve guide bores for oversize valves, as follows:

1. Measure valve stem diameter of old valve being replaced and select proper size valve guide reamer from chart below.

Standard Valve Stem Diameter	Reamer Required for .015 In. Oversize Valve
.341 in. (8.66)	J-5830-02

2. Ream valve guide bores.



72337

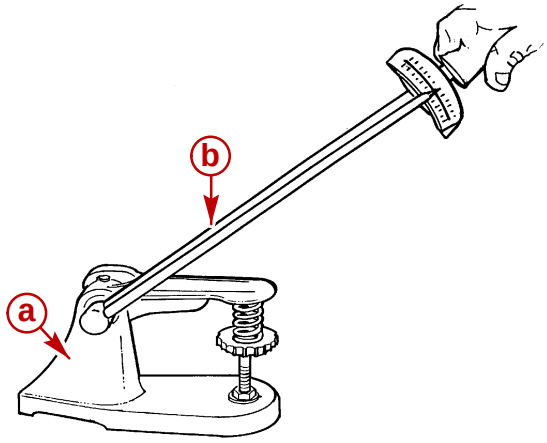
a - Valve Guide Reamer

3. Remove the sharp corner created by reamer at top of valve guide.

Valve Springs - Checking Tension

Use valve spring tester to check valve spring tension with dampers removed. Refer to “Specifications.”

IMPORTANT: Replace the spring if the spring tension is less than 76 lb. (338 N) at 1.70 in (43.2 mm) length.

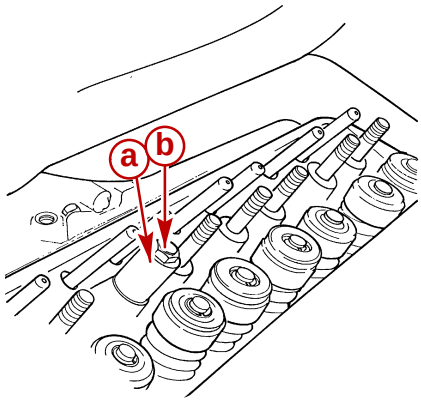


72308

a - Valve Spring Tester (P/N J-9666)
b - Torque Wrench

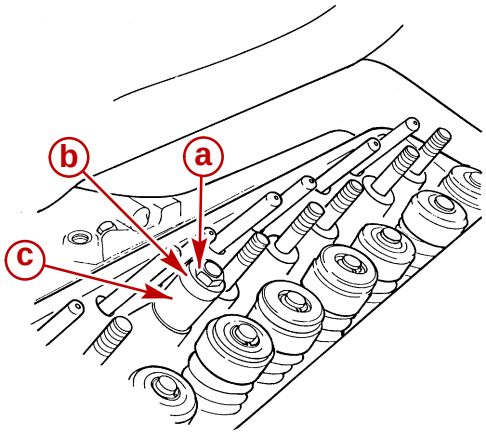
Rocker Arm Stud Replacement

1. Replace worn or loose rocker arm studs with oversize studs.
2. Use rocker arm stud remover to partially remove old stud as follows:
   a. Place large sleeve, flat washer and nut over stud.
   b. Turn nut until it contacts stud threads.
3. Remove nut and install small sleeve on stud.
4. Install nut on stud and turn nut to remove stud.



72309

a - Large Sleeve
b - 3/8-24 Thd. Nut

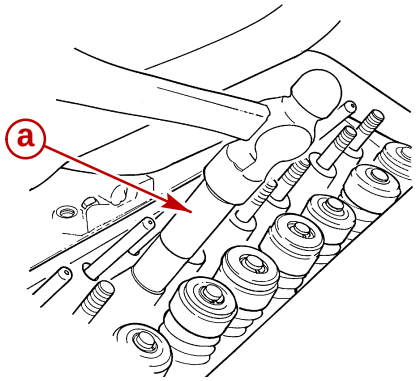


72310

a - Nut
b - Small Sleeve
c - Large Sleeve

5. When installing an oversize stud ream stud hole using appropriate reaming tool.

6. Install new stud with rocker arm stud installer.



72311

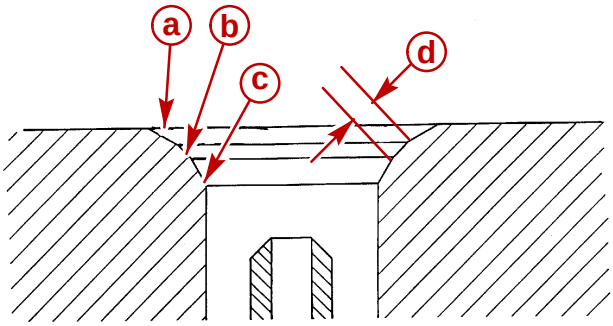
a - Rocker Arm Stud Installer (J-6880)

Valve Seat Repair

Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in valve head is important to ensure that heat will be properly dispersed.

Several different types of equipment are available for reconditioning valve seats. Equipment manufacturer's recommendations should be followed carefully to attain proper results.

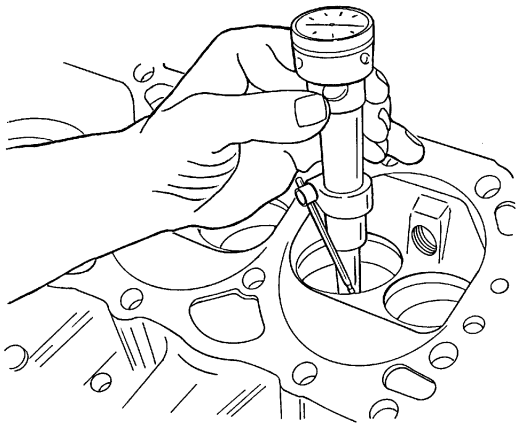


50668

Typical "3 Angle" Valve Seat

a - Top Angle (30°)
b - Seat Angle (46°)
c - Bottom Angle (60°)
d - Seat Width
Intake 1/32-1/16 [.031-.063] in. (0.8-1.5 mm)
Exhaust 1/16-3/32 [.063-.094] in. (1.6-2.3 mm)

Regardless of type of equipment, it is essential that valve guide bores be free from carbon or dirt to achieve proper centering of pilot in valve guide, ensuring concentricity.



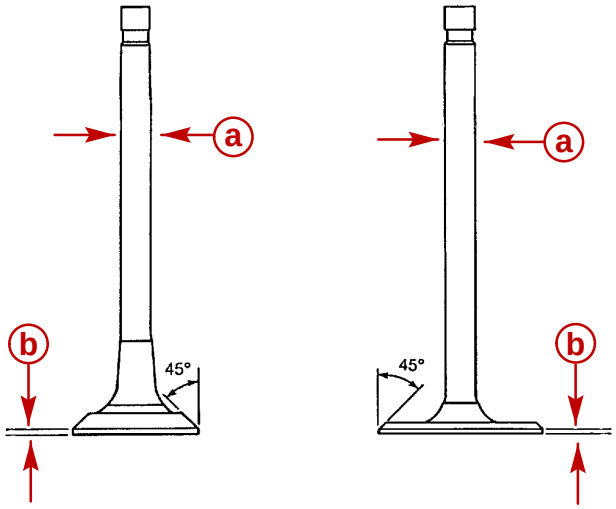
72338

Measuring Valve Seat Concentricity

Valve Grinding

Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive warp or wear must be replaced. When a warped valve head is refaced, a knife edge will be ground on part or all of the valve head due to the amount of metal that must be removed to completely reface. Heat will localize on this edge and lead to breakage, burning or pre-ignition. If the edge of the valve head (valve margin) is less than 0.031 in. (0.79 mm) after grinding, replace the valve.

Several different types of equipment are available for refacing valves. The manufacturer's recommendation should be carefully followed to attain proper results.



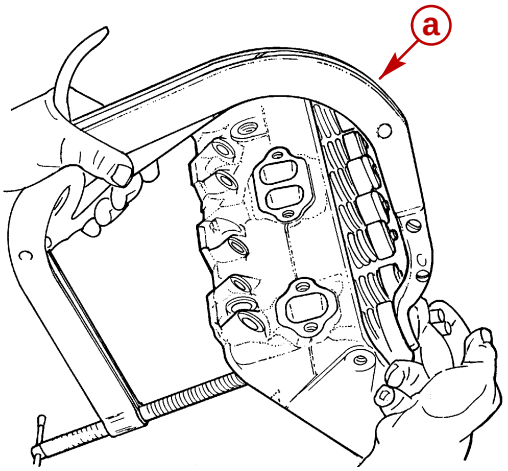
50695

Exhaust **Intake**

a - .341 in. (8.16 mm)
b - 0.031 in. (0.79 mm) Minimum

Reassembly

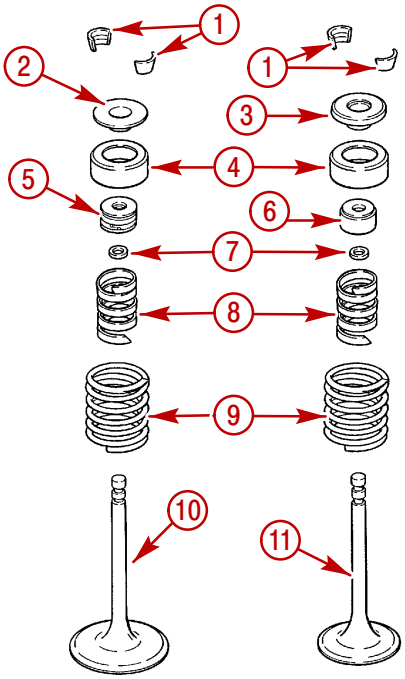
1. Lubricate valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.
3. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.
4. Set valve spring (with damper installed) and shield in place.
5. Place cap on intake valve and/or rotator on exhaust valve.
6. While compressing valve spring install oil seal in lower groove of valve stem. Ensure seal is not twisted. A light coating of oil will help prevent twisting.



72333

a - Valve Spring Compressor (J-8062)

7. Install valve locks (grease may be used to hold them in place) and slowly release tool. Ensure locks seat properly in upper grooves of valve stem.



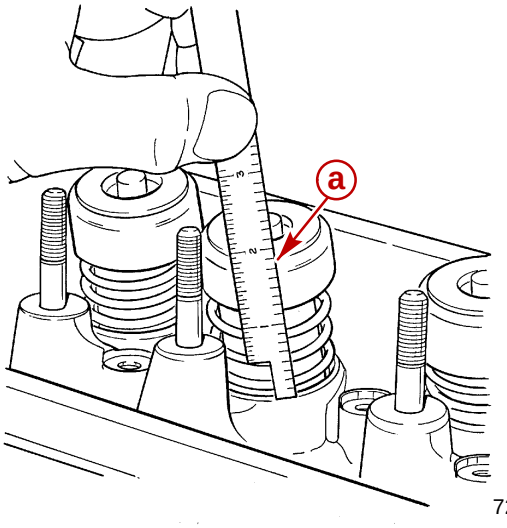
72331

1 - Valve Locks
2 - Retainer
3 - Rotator
4 - Cap
5 - Valve Guide Oil Seal
6 - Oil Shield
7 - Valve Stem Oil Seal
8 - Inner Spring
9 - Outer Spring
10 - Intake Valve
11 - Exhaust Valve

8. Check installed height of valve springs using a narrow, thin scale. Measure from spring seat to top of valve spring, as shown.

IMPORTANT: If measurement exceeds specified height, install a valve spring shim and recheck. DO NOT shim valve springs to give an installed height less than the minimum specified.

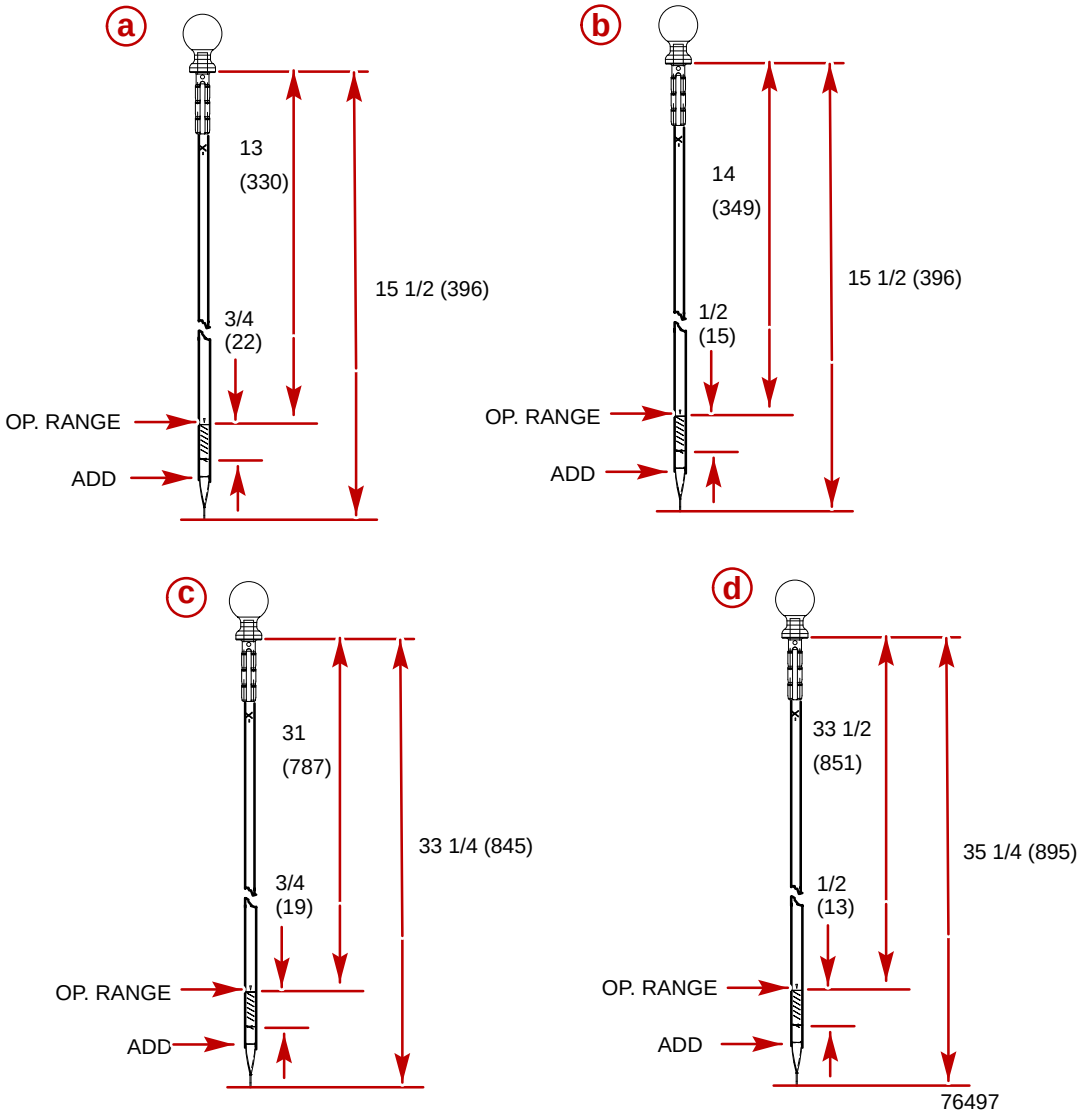
05037



72339

a - Valve Spring Installed Height
b - Cut Away Scale (Grind Out This Portion)

Crankcase Oil Dipstick Specifications

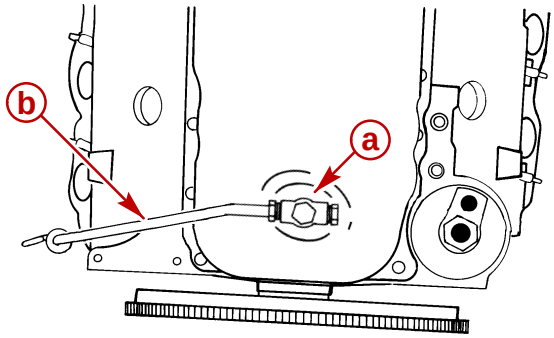


a - All MIE Engines (861942-2)
b - All MIE Engines Remote Drive Transmissions(861942-3)
c - All MCM Service And Ski (861942-7)
d - All MCM Engines (861942-9)

Oil Pan

Removal

1. Drain crankcase oil.
2. If necessary, disconnect outlet hose from seawater pump.
3. Remove dipstick and tube. **On MIE models, be careful not to disturb orientation of banjo fitting on bottom of pan.**



71859

a - Banjo Fitting
b - Dipstick Tube

4. Remove oil pan.

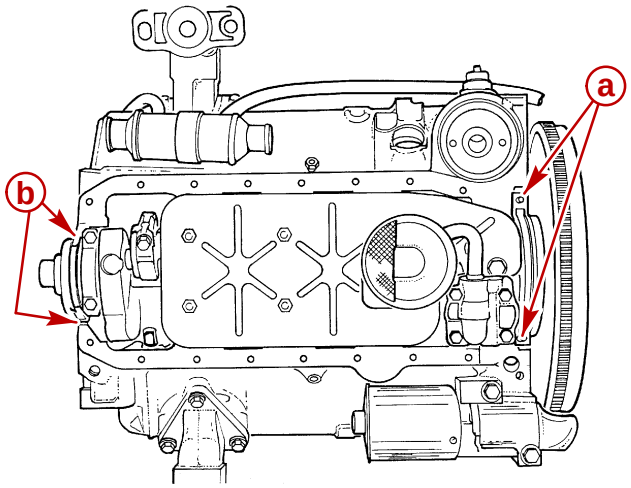
Cleaning and Inspection

1. Clean sealing surfaces of engine block and oil pan.

Installation

1. Apply a small amount of Quicksilver RTV Sealer to joints of rear seal retainer and joints of front cover.

IMPORTANT: Quicksilver RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

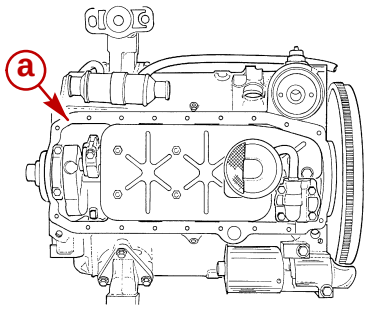


72343

a - Joints of Rear Seal Retainer
b - Joints of Front Cover

2. Install oil pan gasket in position as shown.

NOTE: *A one-piece oil pan gasket may be re-used if it is still pliable and is not cracked, torn or otherwise damaged.*



72344

a - Oil Pan Gasket

3. Install oil pan. Starting from the center and working outward in each direction, tighten oil pan stud nuts to 18 lb-ft (25 Nm) and oil pan reinforcement bolt or stud to 106 lb-in. (12 Nm).

4. Install dipstick tube and dipstick. **On MIE models, install dipstick tube as follows:**

   a. Install banjo fitting as shown. Do not tighten banjo fitting bolt at this time.

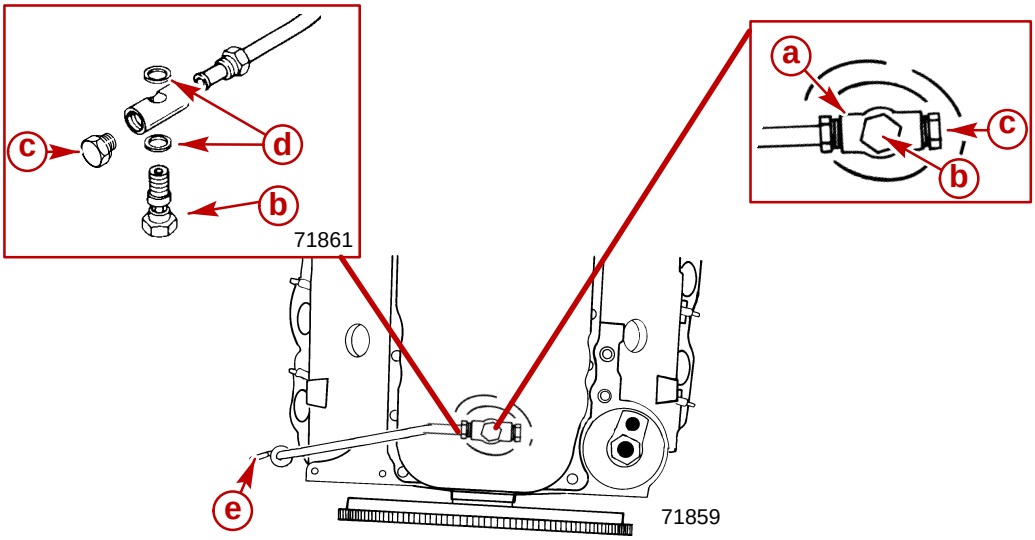
NOTE: *Dipstick tube can be positioned on either side of engine.*

   b. Install dipstick tube and secure with hardware as shown. Do not tighten tube at banjo fitting.

   c. Secure tube at manifold.

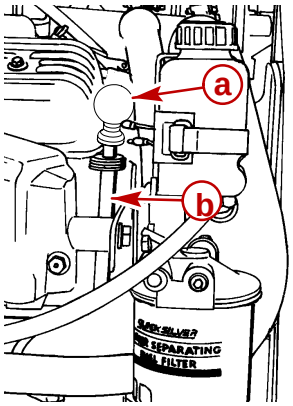
   d. Tighten tube at banjo fitting.

   e. Install plug in banjo fitting.



a - Banjo Fitting
b - Banjo Fitting Bolt
c - Plug
d - Gaskets
e - Dipstick Tube

f. Tighten all connections on banjo fitting at this time. Torque banjo fitting bolt to 180 lb-in. (20 Nm). Tighten dipstick tube and plug securely.



76386

a - Gauge
b - Dipstick Tube

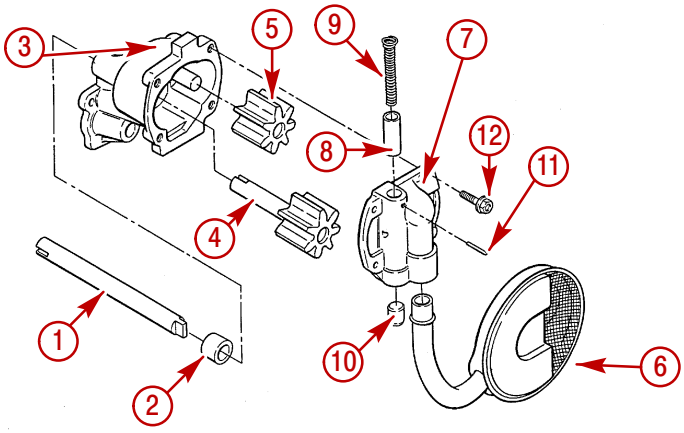
g. Install appropriate gauge.

5. Fill crankcase with required quantity of oil of specified viscosity. See SECTION 1B - “Maintenance.”

Oil Pump

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. It is only available as an assembly. The oil pump is driven by the distributor shaft, which is driven by a helical gear on camshaft.

Exploded View



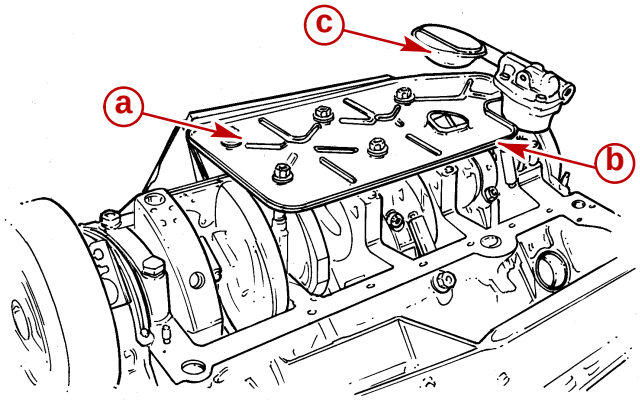
72146

Oil Pump Assembly

1 - Extension Shaft
2 - Shaft Coupling
3 - Pump Body
4 - Drive Gear and Shaft
5 - Idler Gear
6 - Pick Up Screen and Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10 - Plug
11 - Pin
12 - Screws

Removal

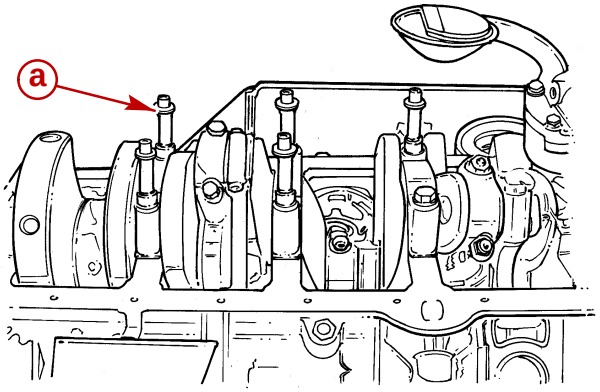
1. Remove oil pan.
2. Remove gasket carefully as the one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn or otherwise damaged.
3. Remove baffle.



77436

a - Nuts (5)
b - Baffle
c - Oil Pump

4. Remove the spacers.



77437

a - Spacers

5. Remove oil pump.

Disassembly

Refer to “Exploded View” in this section.

1. Remove pump cover.

IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear and drive gear from pump body.
3. Remove retaining pin, spring and pressure regulator valve from pump cover.

IMPORTANT: Do not remove pickup screen and pipe assembly unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure.

IMPORTANT: Do not disturb pickup screen on pipe. This is serviced as an assembly.

4. If pickup screen and pipe assembly requires replacement, mount pump in a soft-jawed vise and extract pipe from pump.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage and excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen and pipe.
7. Check pressure regulator valve for fit.

IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

Reassembly

⚠ CAUTION

Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to oil pan bottom when oil pump is installed.

1. If pickup screen and pipe assembly was removed:
   a. Mount pump in a soft-jawed vise.
   b. Apply Quicksilver Perfect Seal to end of new pipe.
   c. Using oil pump suction pipe installer (J-21882), tap the pipe in place with a hammer.

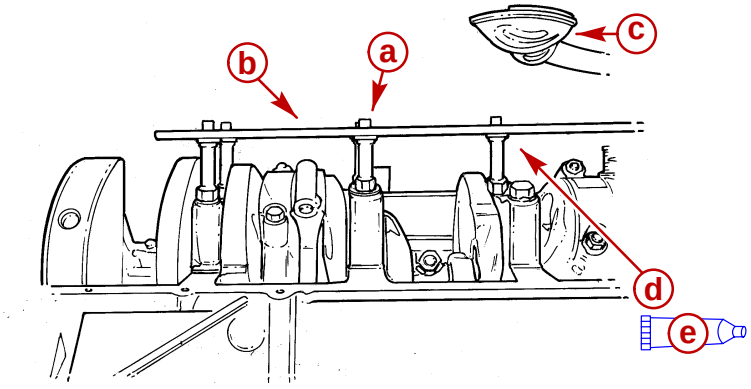
IMPORTANT: Oil internal parts liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear in pump body.
3. Install idler gear in pump body with smooth side of gear toward pump cover opening.
4. Align marks made in disassembly.
5. Fill gear cavity with engine oil.
6. Install pump cover and torque attaching screws to 80 lb-in. (9 Nm).
7. Turn extension shaft by hand to check for smooth operation.

INDEX

Installation

1. Install pump and extension shaft to rear main bearing, aligning extension shaft with distributor drive shaft.
2. Install spacers using Loctite #271.
3. Install baffle. Tighten baffle nuts to 25 lb-ft (34 Nm).
4. Tighten oil pump bolt to 65 lb-ft (88 Nm).



77438

a - 5 Nuts
b - Baffle
c - Oil Pump
d - Spacers
e - Loctite #271

5. Install oil pan as outlined. The one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn or otherwise damaged.

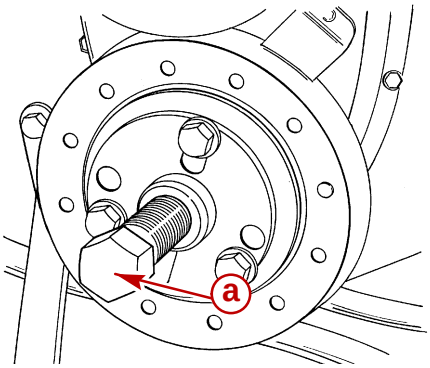
Torsional Damper

Removal

1. Remove drive belts.
2. Remove drive pulley,
3. Remove torsional damper retaining bolt.

IMPORTANT: Do not use a universal claw type puller to remove torsional damper (in next step) as outside ring of torsional damper is bonded in rubber to the hub and use of claw type puller may break the bond.

4. Remove torsional damper with torsional damper remover and installer. (J-23523-E)



72345

a - Torsional Damper Remover and Installer (J-23523-E)

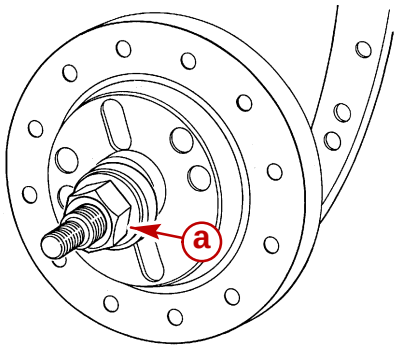
Installation

IMPORTANT: The inertia weight section of the torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Replace key in crankshaft if it is damaged.
2. Coat seal surface of torsional damper with engine oil.
3. Install torsional damper on crankshaft, using torsional damper remover and installer as follows:
   a. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft at least 1/2 in. (13 mm) to prevent damage to threads.

   b. Install plate, thrust bearing, washer and nut on rod.
   c. Install torsional damper on crankshaft by turning nut until it contacts.



72346

a - Torsional Damper Remover and Installer (J-23523-E)

   d. Remove tool from crankshaft.
   e. To prevent oil leakage, apply Quicksilver RTV sealant to torsional damper keyway.
   f. Install torsional damper bolt. Torque to 60 lb-ft (81 Nm).
4. Install drive pulley(s). Torque bolts to 35 lb-ft (48 Nm).
5. Install and adjust drive belts.

Crankcase Front Cover Oil Seal

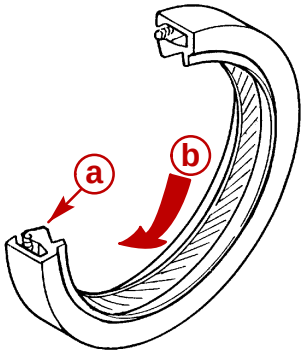
Oil Seal Replacement (Without Removing Front Cover)

REMOVAL

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver. Be careful not to distort front cover or damage crankshaft.

INSTALLATION

1. Apply Quicksilver Perfect Seal to seal retainer mating surface and apply grease to seal lips.

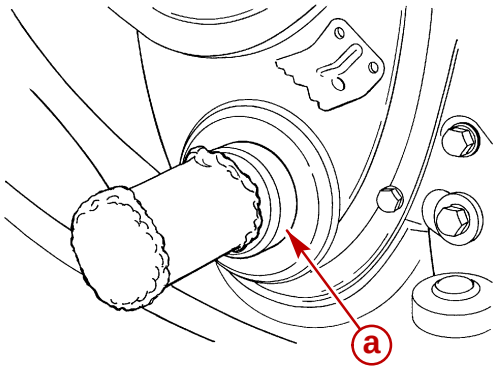


73124

a - Seal Lip Toward Inside of Engine
b - Rotation of Crankshaft as Viewed from Front End Looking Toward Flywheel End

2. Install new seal with open end of seal inward, using crankcase front cover seal installer. Drive seal in until it just contacts.

IMPORTANT: Do not use excessive force.



72347

a - Crankcase Front Cover Seal Installer (J-35468)

3. Reinstall torsional damper as outlined.

Crankcase Front Cover

Removal

1. Remove engine from boat if necessary to gain access to cover.
2. Remove torsional damper and oil pan.
3. Remove water circulating pump.

IMPORTANT: Crankcase front cover is not reusable per G.M. Specification. It must be replaced if removed.

4. Remove crankcase front cover.
5. If damaged, drive oil seal out of front cover (from the rear) using a punch.

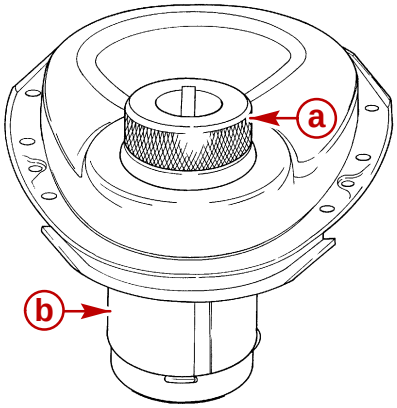
Cleaning and Inspection

1. Clean old gasket material and sealer from mating surfaces on cylinder block.

IMPORTANT: Surfaces must be clean and flat or oil leakage may result.

Installation

1. Install oil seal in new cover with lip of seal toward inside of engine, using crankcase front cover seal installer. Support cover around seal area with appropriate tool as shown.



72348

a - Crankcase Front Cover Seal Installer (J-35468)
b - Support (to Prevent Distorting Cover)

2. Coat both sides of front cover gasket with Quicksilver Perfect Seal and place in position on engine.
3. Install front cover, making sure holes in cover align with dowel pins in block. Torque front cover attaching screws to 106 lb-in. (12 Nm).

4. Install oil pan and torsional damper as outlined.
5. Install water circulating pump.
6. Reinstall engine in boat.
7. Fill crankcase with engine oil.
8. Follow procedures in SECTION 6A or 6B of Service Manual Number 24:

Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see SECTION 6A).

Closed Cooled Models: Refill closed cooling section (see SECTION 6B), and provide adequate water supply to seawater pickup.

⚠ CAUTION

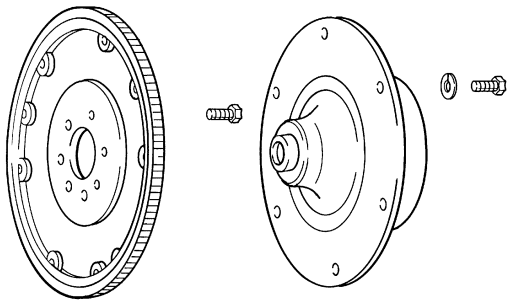
Ensure that cooling water supply is available before starting the engine.

9. Start engine and check for water and oil leaks.

Flywheel

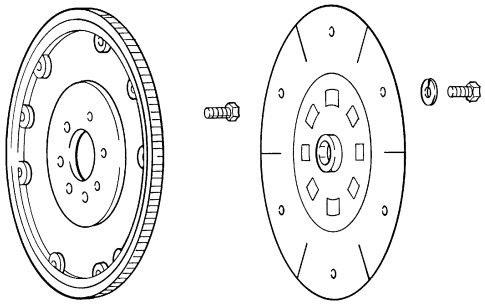
Removal

1. Remove engine from boat.
2. Remove transmission, if equipped.
3. Remove flywheel housing and related parts.
4. Remove MCM coupler or MIE drive plate.
5. Remove flywheel.



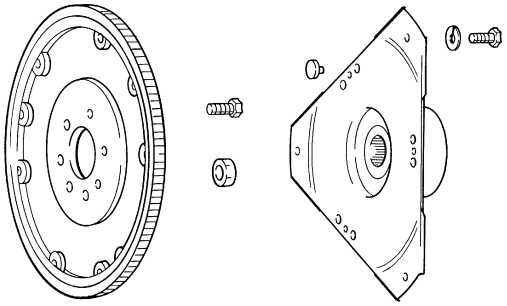
72350

Bravo Coupler



72351

MIE Drive Plate



72352

Drive Shaft Extension Coupler

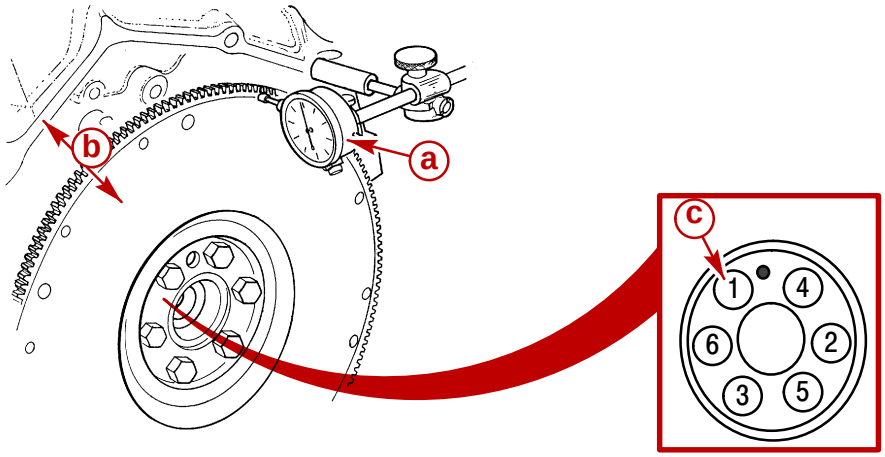
Cleaning and Inspection

1. Inspect splines in drive plate or coupler for wear.
2. Check flywheel ring gear for worn and missing teeth.
3. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean bare metal.

Installation

NOTE: *Pilot bushing can be reused. The pilot bushing can be removed without damage by filling pilot bushing cavity with grease, then inserting an old transmission input shaft in bore of bushing and hitting it with a hammer. This will create hydraulic pressure in pilot bushing cavity that should force bushing out.*

1. Install flywheel while aligning dowel hole in flywheel with dowel in crankshaft. Apply Loctite 27131 to threads of flywheel bolts. Torque bolts in sequence to 75 lb-ft (100 Nm).
2. Check flywheel runout as follows:
   a. Attach a dial indicator to engine block.
   b. Take readings around outer edge of flywheel. Push in on flywheel to remove crankshaft end play.
   c. Maximum runout - .008 in. (0.203 mm).



72353

a - Dial Indicator
b - Push Flywheel and Crankshaft Forward as Far as It Will Go When Taking Reading
c - Torque Sequence

3. Install drive coupler or drive plate. Torque bolts to 35 lb-ft (48 Nm).
4. Install flywheel housing and related parts. Torque bolts to 30 lb-ft (41 Nm).
5. Install flywheel housing cover. Torque bolts to 80 lb-in. (9 Nm).
6. Install transmission (MIE). Torque bolts to 50 lb-ft (68 Nm).
7. Install engine.

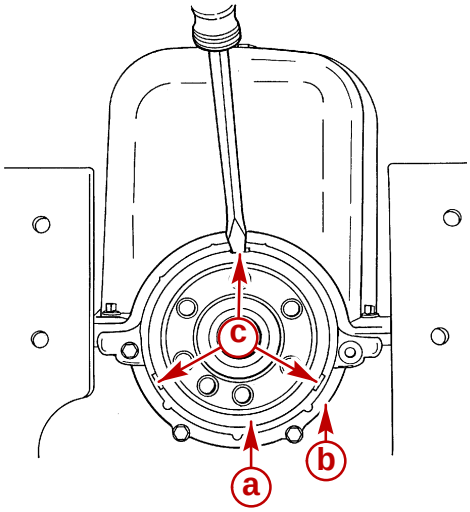
INDEX

Rear Main Oil Seal

The rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

Removal

1. Remove the flywheel.
2. Remove seal by using a screwdriver to pry it out of the seal retainer as shown.



72355

a - Rear Seal
b - Seal Retainer
c - Slots (Three)

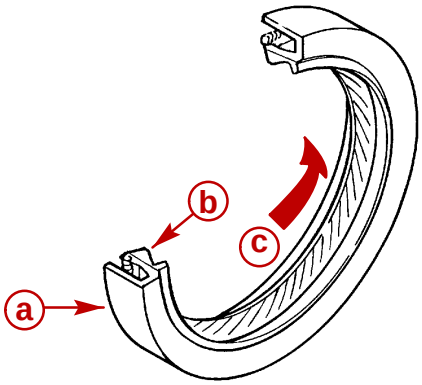
Cleaning and Inspection

1. Clean crankshaft seal running surface.
2. Clean the seal retainer bore.

Installation

1. Apply a thin coat of clean engine oil to the bore of the seal retainer.
2. Apply a thin coat of clean engine oil to the outer diameter of the seal.

IMPORTANT: Do not allow oil or other lubricants to contact the seal surface of the rear oil main seal.

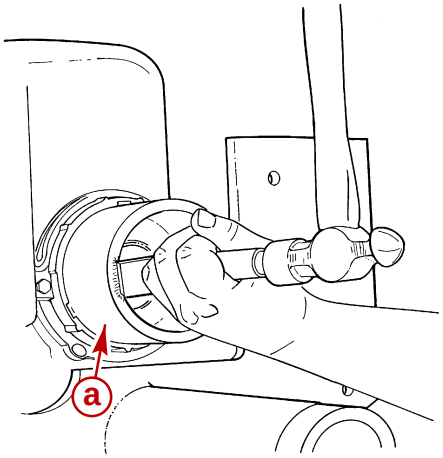


73127

a - Rear Main Oil Seal
b - Seal Lip Toward Inside of Engine
c - Rotation of Crankshaft as Viewed from Flywheel End Looking Forward

INDEX

3. Install seal using rear main seal installer as shown.



72356

a - Rear Main Seal Installer (J-26817-A)

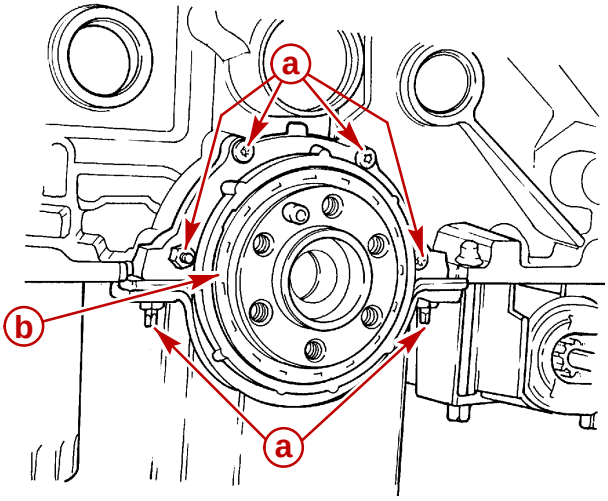
NOTE: *Tool J35621-A (not shown) may also be used to install the seal. This tool holds the seal and attaches to the crankshaft. The seal is then pressed into the seal retainer by turning the large wing nut on the tool.*

Rear Main Oil Seal Retainer

The rear main oil seal retainer can only be replaced with the oil pan removed.

Removal

1. Remove oil pan.
2. Remove oil seal retainer fasteners.
3. Remove oil seal retainer.



72464

a - Fasteners
b - Oil Seal Retainer

4. Remove old gasket.

Cleaning and Inspection

1. Clean gasket material from mating surfaces.
2. Inspect oil seal retainer for cracks or scored surface.
3. Inspect oil seal for worn, dry or torn rubber. Replace if necessary (refer to “Rear Main Oil Seal” as outlined).
4. Inspect alignment pin for damage. Replace if necessary.

Installation

IMPORTANT: Always use a new crankshaft rear main oil seal and new oil seal retainer gasket when installing the crankshaft rear main oil seal retainer.

1. Install new oil seal retainer gasket.

IMPORTANT: Do not allow oil or other lubricants to contact the seal surface of the rear main oil seal.

2. Install the crankshaft rear oil seal retainer on to the studs.
3. Install retainer nuts and bolts. Torque to 106 lb-in. (12 Nm).
4. If not already installed, install the Rear Main Oil Seal as outlined.
5. Install oil pan as outlined.

NOTE: *A one-piece oil pan gasket may be re-used if it is still pliable and is not cracked, torn or otherwise damaged.*

INDEX

Main Bearings

IMPORTANT: Before removing main bearing caps or connecting rod caps, mark them for reassembly in their original locations.

Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and .001 in., .010 in. and .020 in. undersize.

Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. For this reason you may find one-half of a standard insert with one-half of a .001 in. undersize insert which will decrease the clearance .0005 in. from using a full standard bearing.

When a production crankshaft cannot be precision fitted by this method, it is then ground .009 in. undersize ON ONLY THOSE MAIN JOURNALS THAT CANNOT BE PROPERLY FITTED. ALL JOURNALS WILL NOT NECESSARILY BE GROUND UNDERSIZE. A .009 in. undersize bearing and .010 in. undersize bearing may be used for precision fitting in the same manner as previously described.

Inspection

In general, the lower half of the bearing (except No. 1 bearing) shows a greater wear and the most distress from fatigue. If upon inspection the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

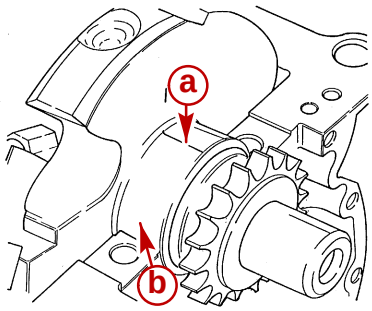
Checking Clearances

To obtain accurate measurements while using Plastigage, or its equivalent, engine must be out of the boat and upside down so crankshaft will rest on the upper bearings and total clearance can be measured between lower bearing and journal.

To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, preparatory to checking fit of bearings, the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. With the oil pan and oil pump removed, remove bearing cap and wipe oil from journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.

NOTICE
Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

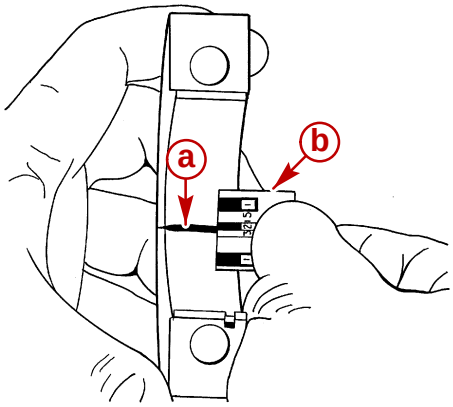


72357

a - Gauging Plastic
b - Journal

INDEX

3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap MUST be torqued to specification to ensure proper reading. Variations in torque affect the compression of the plastic gauge.
4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.
5. On the edge of the gauging plastic envelope there is a graduated scale which is correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduations on the gauging plastic envelope as shown.



72358

a - Compressed Gauging Plastic
b - Graduated Scale

NOTE: *Normally main bearing journals wear evenly and are not out of round.*

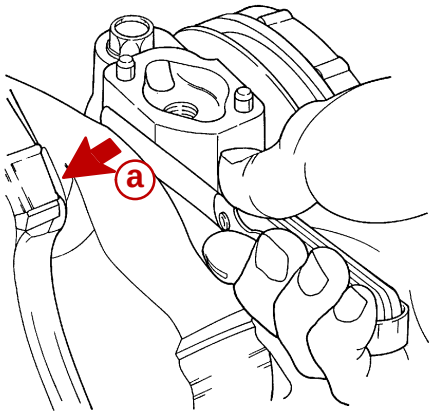
- *if a bearing is being fitted to an out-of-round journal (.001 in. max.), be sure to fit to the maximum diameter of the journal.*
- *If the bearing is fitted to the minimum diameter, and the journal is out of round .001 in., interference between the bearing and journal will result in rapid bearing failure.*
- *If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal.*
- *Measure the journal with a micrometer if the flattened gauging plastic indicates more than .001 in. difference.*

6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard or .001 in. undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.

IMPORTANT: After selecting new bearing, recheck clearance.

8. Proceed to the next bearing. After all bearings have been checked, rotate the crankshaft to check for excessive drag. When checking No. 1 main bearing, loosen accessory drive belts to prevent tapered reading with plastic gauge.

9. Measure crankshaft end play (see “Specifications”) by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge as shown.

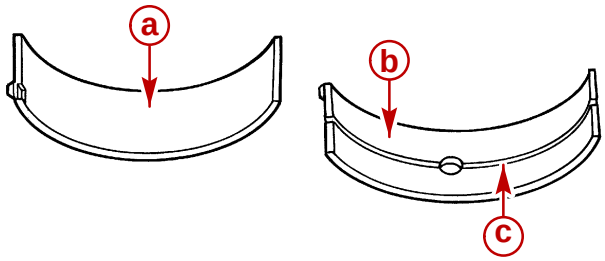


72360

a - Force Crankshaft to Extreme Forward Position

Replacement

NOTE: *Main bearings may be replaced with or without removing crankshaft.*



72359

Main Bearing Inserts

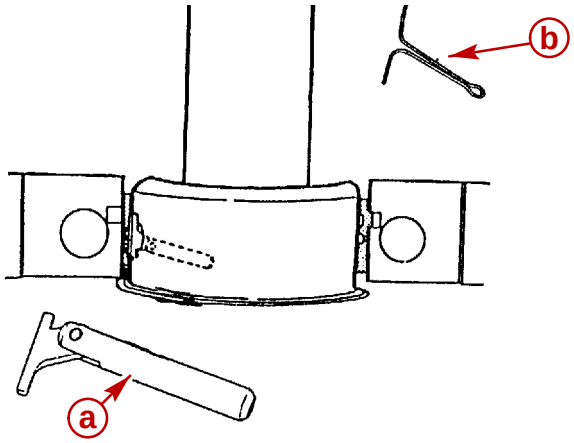
a - Lower Bearing Insert
b - Upper Bearing Insert
c - Oil Groove

WITH CRANKSHAFT REMOVED

1. Remove and inspect the crankshaft.
2. Remove the main bearings from the cylinder block and main bearing caps.
3. Coat bearing surfaces of new main bearings with oil.
4. Install the upper bearings in cylinder block.
5. Install the lower bearings in main bearing caps.
6. Install the crankshaft.

WITHOUT CRANKSHAFT REMOVED

1. Remove oil pan, oil pump and spark plugs.
2. Remove cap on main bearing requiring replacement.
3. Remove bearing from cap.
4. Install main bearing remover/installer in oil hole in crankshaft journal. If such a tool is not available, a cotter pin may be bent, as shown, and used.



72622

a - Main Bearing Remover/Installer (J-8080)
b - Cotter Pin

5. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll upper bearing out of block.
6. Oil new upper bearing.
7. Insert plain (unnotched) end between crankshaft and indented or notched side of block.
8. Rotate the bearing into place and remove tool from oil hole in crankshaft journal.
9. Oil new lower bearing and install in bearing cap.
10. Install main bearing cap with arrows pointing toward front of engine.
11. Torque all main bearing caps, EXCEPT THE REAR MAIN CAP, to specifications.
12. Torque rear main bearing cap to 15 lb-ft (20 Nm); then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces.
13. Torque rear main bearing cap to specification.

Connecting Rod Bearings

Connecting rod bearings are of the precision insert type and do not use shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and .001 in. and .002 in. undersize for use with new and used standard size crankshafts. They are also available in .010 in. and .020 in. undersize for use with reconditioned crankshafts.

When removing a connecting rod cap, you may find a .010 in. undersize bearing. These are used in manufacturing for selective fitting.

⚠ CAUTION

Connecting rod bearings are chamfered. The chamfered bearing must be installed facing outward or the bearing will seize.

Inspection and Replacement

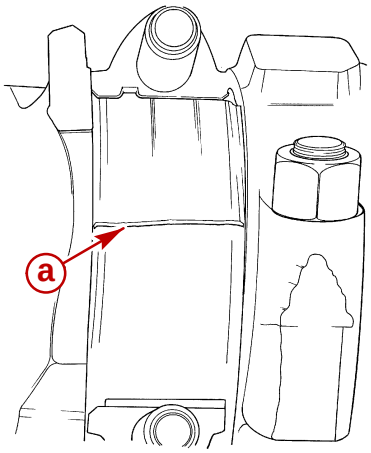
IMPORTANT: Before you remove the connecting rod cap, mark the side of the rod and cap with the cylinder number to assure matched reassembly of rod and cap.

1. Remove oil pan and oil pump.
2. Remove connecting rod cap and bearing.
3. Inspect bearing for evidence of wear and damage. Do not reinstall a worn or damaged bearing.
4. Wipe both upper and lower bearing shells and crankpin clean of oil.
5. Measure the crankpin for out-of-round or taper with a micrometer.
   a. If not within specifications, replace or recondition the crankshaft.
   b. If within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine required bearing size.

NOTE: *If within specifications, measure new or used bearing clearances with gauging plastic. If a bearing is being fitted to an out-of-round crankpin, be sure to fit to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter, and the crankpin is out of round .001 in., interference between the bearing and crankpin will result in rapid bearing failure.*

6. Measure bearing clearances.
   a. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin or bearing surface as shown.

b. Position the gauging plastic in the middle of the bearing shell. Bearings are eccentric and false readings could occur if placed elsewhere.



72361

a - Gauging Plastic

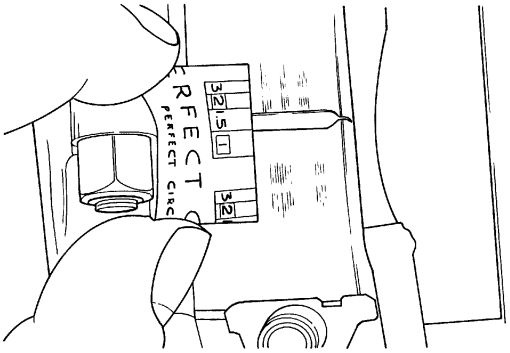
c. Install the bearing in the connecting rod and cap.

d. Install the bearing cap. Bearing cap MUST be torqued to specification in order to ensure proper reading. Variations in torque affect the compression of the plastic gauge.

e. Evenly,and in a two pass sequence, torque nuts to 20 lb-ft (27 Nm) on first pass. Then, torque nuts an additional 45 degrees angular torque.

NOTICE
Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

f. Remove the bearing cap and use the scale on the gauging plastic envelope to measure the gauging plastic width at the widest point.



72362

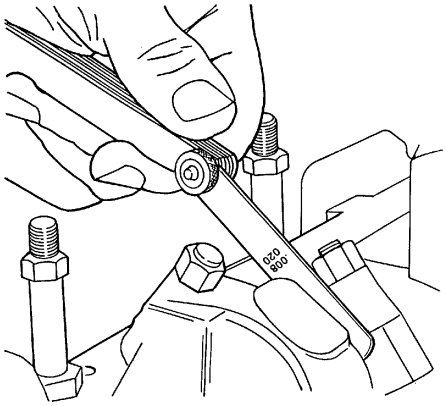
7. If the clearance exceeds specifications, select a new, correct size bearing and remeasure the clearance.

NOTE: *Be sure to check what size bearing is being removed in order to determine proper replacement size bearing. If clearance cannot be brought to within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.*

8. Coat the bearing surface with oil.

9. Install the rod cap.

10. Evenly,and in a two pass sequence, torque nuts to 20 lb-ft (27 Nm) on first pass. Then, torque nuts an additional 55 degrees angular torque.
11. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to ensure clearance.
12. Measure all connecting rod side clearances (see “Specifications”) between connecting rod caps as shown.



72363

Connecting Rod / Piston Assembly

Removal

1. Remove oil pan and dipstick tube.
2. Remove baffle and oil pump.
3. Remove distributor and intake manifold.
4. Remove cylinder heads.

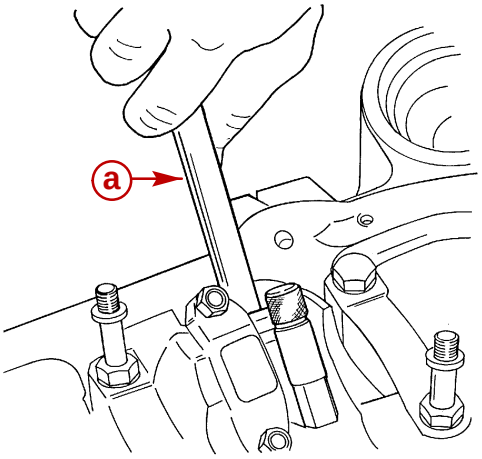
IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

5. Use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.
6. Mark connecting rods and bearing caps (left bank 1, 3, 5 and 7; right bank 2, 4, 6 and 8 from front to rear on same side as piston thrust).

7. Remove connecting rod cap and install connecting rod bolt guide (3/8-24) on bolts to prevent scratches. Push connecting rod and piston assembly out of top of cylinder block.

NOTE: *Spark plug boots can be cut and used in place of connecting rod bolt guides.*

NOTE: *Turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.*

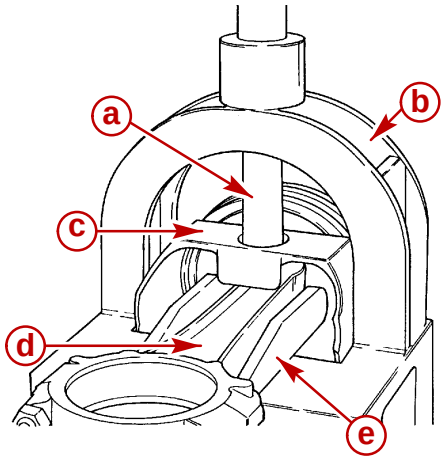


72364

a - Connecting Rod Bolt Guide 3/8-24 (J-5239)

Disassembly

Disassemble piston from connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72365

a - Piston Pin Remover (J-24086-B)
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

Cleaning and Inspection

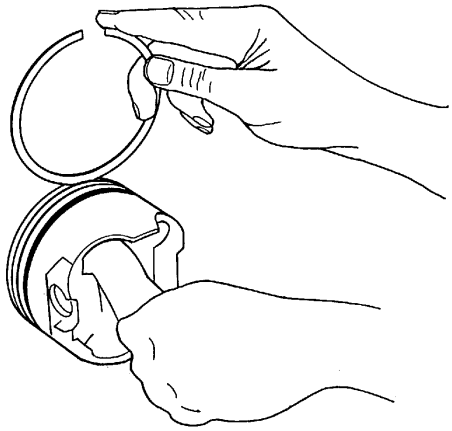
CONNECTING RODS

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted and bent rods and inspect for nicks and cracks. Replace damaged connecting rods.

PISTONS

NOTE: *Cylinder bore and taper must be within specifications before pistons can be considered for re-use.*

1. Clean varnish from piston skirts with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with a groove cleaner and make sure oil ring holes are clean.
2. Inspect piston for damaged ring lands, skirts and pin bosses, wavy or worn ring lands, scuffed or damaged skirts and eroded areas at top of piston.
3. Inspect grooves for nicks and burrs that might cause rings to hang up.
4. Measure piston skirt and check clearance as outlined under “Piston Selection.”
5. Slip outer surface of a new top and second compression ring into respective piston ring-groove and roll ring entirely around the groove to make sure that ring is free as shown. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, recheck with another ring.



72366

6. Proper clearance of piston ring in its groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. See “Specifications.”

7. Replace pistons that are damaged or show signs of excessive wear.

72367

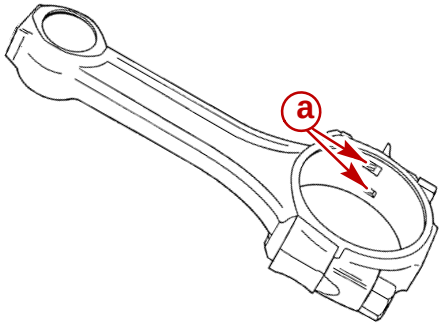
PISTON PINS

1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish and scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001 in. (0.025 mm) wear limit, replace piston and piston pin assembly.

Reassembly

IMPORTANT: When reassembling pistons and connecting rods, the following must be kept in mind.

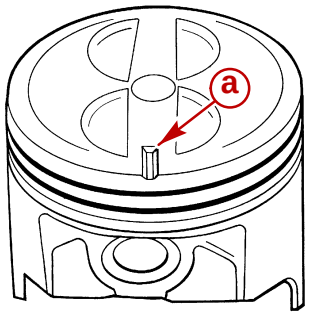
- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of cylinder block.**
- **Connecting rod bearings are chamfered and must be installed with chamfer facing outward.**



72368

a - Rod Bearing Tangs

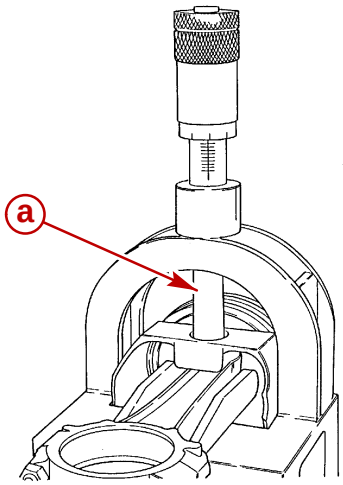
- **To determine if engine is left-hand (standard) rotation or right-hand (opposite) rotation, inspect camshaft drive. If engine has a timing chain, engine is left-hand rotation. If engine has timing gears, engine is right-hand rotation. All MCM engines are left-hand rotation.**
- **Notch on piston must be positioned correctly for engine that is being repaired.**



72370

a - Notch - Toward Front

1. Assemble piston to connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72371

a - Piston Pin Remover (J-24086-B)

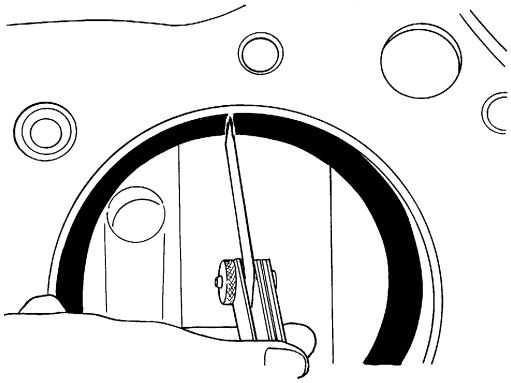
2. Once assembled, check piston for freedom of movement (back and forth and up and down) on connecting rod. Piston should move freely in all directions. If it does not, piston pin bore is tight and piston / pin assembly must be replaced.
3. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

PISTON RINGS

When installing compression rings, ensure that marked side is correctly positioned.

Oil control rings are a three-piece type, consisting of two rings and a spacer.

1. Select rings comparable in size to cylinder bore and piston size.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4 in. (6 mm) below ring travel. Ensure that ring is square with cylinder wall.
3. Measure gap between ends of ring with a feeler gauge as shown.



72372

4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons, if not previously done.
7. Install piston rings as follows:
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to make sure ring is free. If binding occurs at any point, the cause should be determined. If binding is caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.

IMPORTANT: Use piston ring expander (91-24697) for compression ring installation.

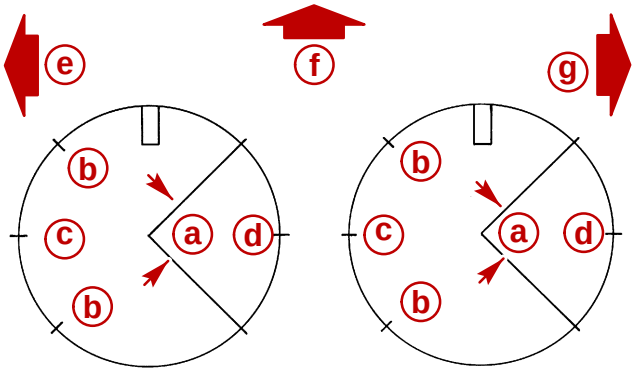
   e. Using ring expander, install lower compression ring with marked side up.
   f. Using ring expander, install top compression ring with marked side up.

Installation

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings.
2. Install connecting rod bearings in rods and rod caps with chamfer facing outward.
3. Lightly coat pistons, rings and cylinder walls with light engine oil.
4. With bearing caps removed, install connecting rod bolt guide 3/8-24 (J-5239) on connecting rod bolts.

IMPORTANT: Be sure ring gaps are properly positioned as shown.



72373

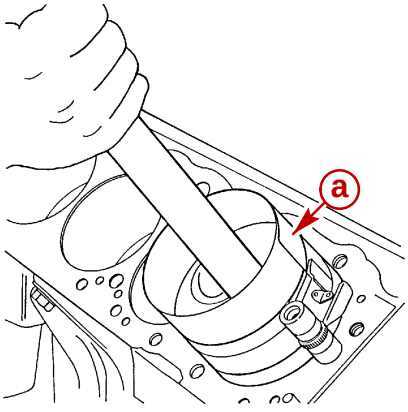
1-3-5-7 Cylinders **2-4-6-8 Cylinders**

Ring Gap Location

- **a -** Oil Ring Spacer Gap (Tang in Hole or Slot Within Arc)
- **b -** Oil Ring Rail Gaps
- **c -** 2nd Compression Ring Gap
- **d -** Top Compression Ring Gap
- **e -** Engine Left
- **f -** Engine Front
- **g -** Engine Right

5. Install each connecting rod and piston assembly in its respective bore with connecting rod bearing tangs toward outside of cylinder block.
6. Use piston ring compressor to compress rings.
7. Guide connecting rod into place on crankshaft journal with connecting rod bolt guide. Use a hammer handle with light blows to install piston into bore.
8. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3, 5 and 7 in left bank and 2, 4, 6 and 8 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.



72374

- **a -** Piston Ring Compressor (J-8037)

INDEX

9. Remove connecting rod bolt guide.
10. Install bearing caps and torque nuts to 45 lb-ft (61 Nm).
11. Check connecting rod side clearance as previously described.

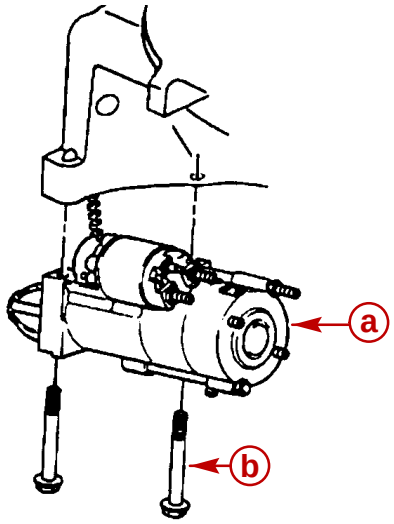
NOTE: *If bearing replacement is required, refer to "Connecting Rod Bearings."*

12. Install oil pump and baffle.
13. Install dipstick and oil pan.
14. Install cylinder heads.
15. Install intake manifold.
16. Install distributor.
17. Fill crankcase with oil. Refer to SECTION 1 - "Maintenance."
18. Adjust valves as outlined under "Valve Adjustment - Engine Stopped."

Crankshaft

Removal

1. Remove engine from boat.
2. Drain crankcase oil.
3. Remove starter.

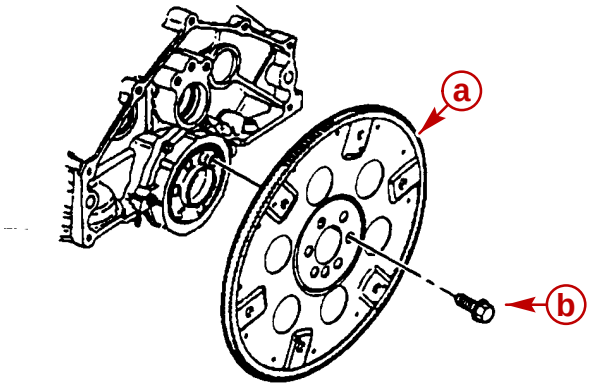


76489

a - Starter
b - Mounting Bolts

4. Remove flywheel housing.

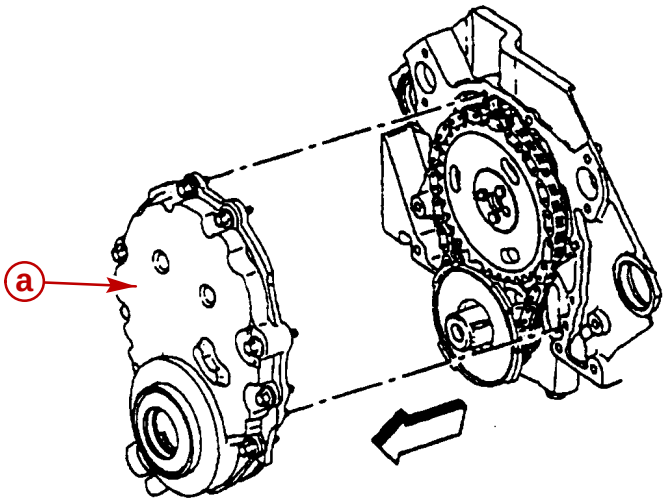
5. Remove drive coupler/plate and flywheel.



76490

a - Flywheel
b - Bolts

6. Remove belts.
7. Remove circulating pump.
8. Remove crankshaft pulley and torsional damper.
9. Remove spark plugs.
10. Remove oil pan and dipstick tube.
11. Remove baffle and oil pump.
12. Remove timing chain gear cover.

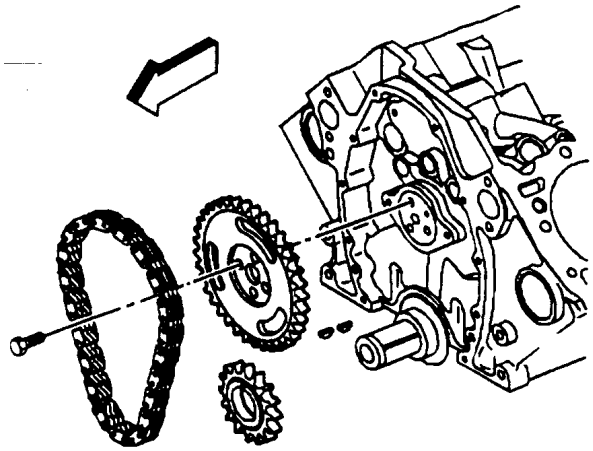


76491

a - Timing Chain Gear Cover

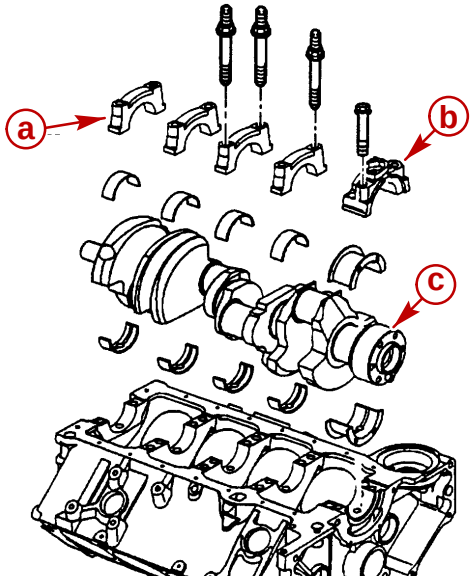
13. Remove timing chain.
14. Turn crankshaft to align timing mark with camshaft mark.

15. Remove camshaft sprocket or gear.



76488

16. Remove rear main seal and retainer.
17. Ensure all bearing caps (main and connecting rods) are marked so they can be reinstalled in their original locations.
18. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.
19. Remove main bearing caps and carefully lift crankshaft out of cylinder block.



76492

a - Connecting Rod Bearing Caps
b - Main Bearing Cap
c - Crankshaft

20. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined.

Cleaning and Inspection

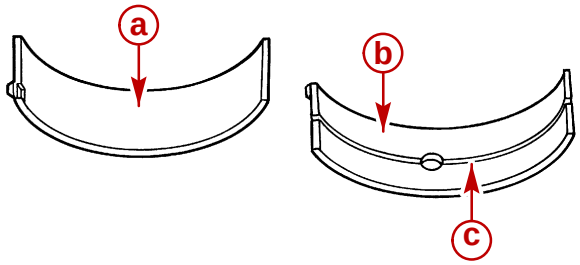
1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize (see “Specifications”).
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in V-blocks) and check at front and rear intermediate journals with a dial indicator (see “Specifications”).
4. Replace or recondition crankshaft if not within specifications.

Installation

1. Remove timing sprocket or gear from old crankshaft and reinstall on new crankshaft as outlined.
2. On driveshaft extension models, if old pilot bushing is to be reused, bushing can be removed without damage by filling pilot bushing cavity with grease, then insert an old transmission input shaft in bore of bushing and hit it with a hammer. This will create hydraulic pressure in pilot bushing cavity that should force bushing out.

IMPORTANT: Be sure that all bearings and crankshaft journals are clean.

3. Install main bearings in engine block.



72359

Main Bearing Inserts

a - Lower Bearing Insert (Install in Cap)
b - Upper Bearing Insert (Install in Block)
c - Oil Groove

4. Carefully lower crankshaft into place. Be careful not to damage bearing surface.
5. Check clearance of each main bearing, following procedure outlined under “Main Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
6. Install main bearing caps.
7. Torque bolts to specifications. When tightening rear main bearing cap, follow procedure outlined under “Main Bearings.”
8. Check crankshaft end play as outlined.
9. Install rear main seal retainer and seal.
10. Torque fasteners to 106 lb-in. (12 Nm).
11. Check clearance for each connecting rod bearing, following procedure under “Connecting Rod Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
12. Coat the bearing surface with oil, install the rod cap.
13. Torque nuts to 20 lb-ft (27 Nm) on first pass. Then, torque nuts an additional 55 degrees angular torque.

INDEX

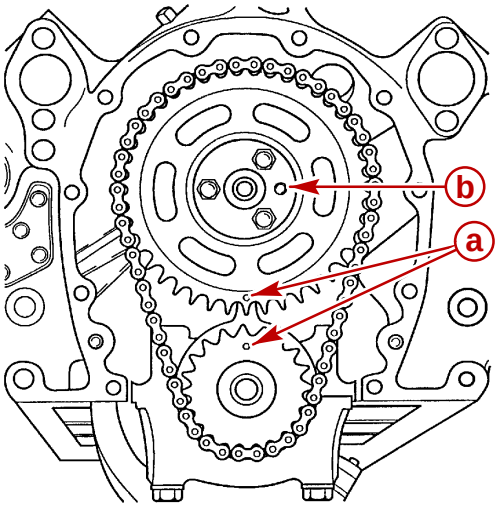
14. Turn crankshaft so mark on timing sprocket or gear is facing camshaft.
15. Install timing chain and sprocket or gear on camshaft -align marks with crankshaft.
16. Install timing chain/gear cover.
17. Install oil pump and baffle.
18. Install dipstick tube and oil pan.
19. Install spark plugs.
20. Install torsional damper and crankshaft pulley.
21. Install water pump.
22. Install belts.
23. Install flywheel and drive coupler / plate.
24. Install flywheel housing.
25. Install starter.
26. Install new oil filter.
27. Fill crankcase with oil.
28. Install engine in boat.

Timing Chain and Sprocket

Removal

1. Remove torsional damper, oil pan and crankcase front cover.
2. Turn crankshaft until timing marks on crankshaft and camshaft sprockets are in alignment.

NOTE: *Flat lifter timing gear is shown. Roller lifter gears have similar timing marks.*



72376

Standard (LH) Rotation Shown

a - Timing Marks Aligned
b - Locating Pin

3. Remove camshaft gear or sprocket and timing chain. If gear or sprocket does not come off easily, a light tap on the lower edge of the gear or sprocket with a plastic mallet should dislodge it.
4. Remove crankshaft sprocket or gear if either requires replacement.

Cleaning and Inspection

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing chain for wear and damage.
3. Inspect sprockets for wear and damage.
4. Inspect timing gears for worn and damaged teeth.
5. Inspect camshaft gear-to-cylinder block contact surfaces for damage.

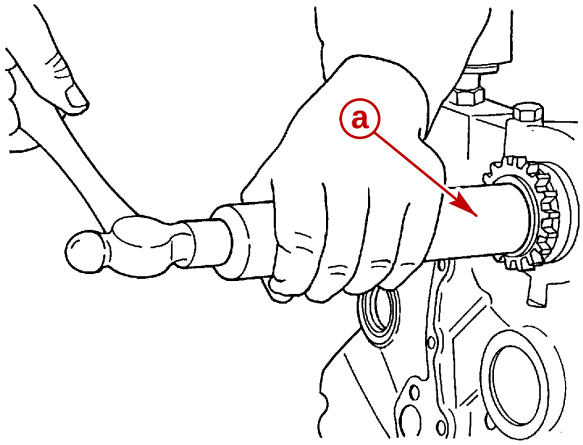
Crankshaft Sprocket/Gear

Removal

1. Remove torsional damper and crankcase front cove.
2. Remove camshaft timing chain/gear.
   a. On left-hand rotation engines, remove crankshaft sprocket using crankshaft gear and sprocket puller (J-5825-A).
   b. On right-hand rotation engines, remove crankshaft gear using a universal puller.

Installation

1. Using crankshaft gear and sprocket installer, as shown, install sprocket or gear on crankshaft.



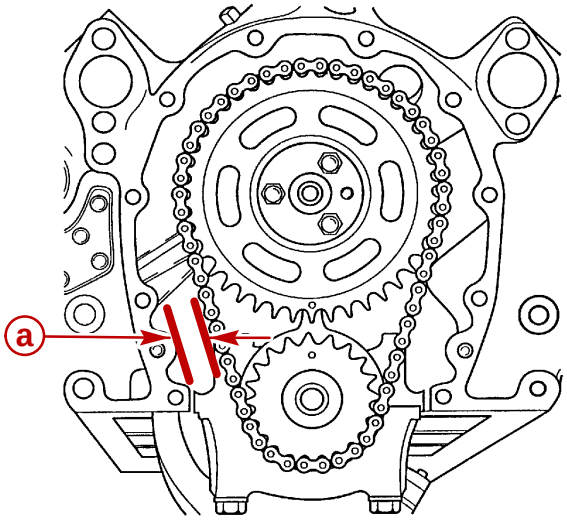
72377

a - Crankshaft Gear and Sprocket Installer (J-5590)

2. Install timing chain or gear.
3. Install crankcase cover and torsional damper.

Checking Timing Chain Deflection

1. Install timing chain and sprockets.
2. Rotate camshaft (in either direction) to place tension on one side of the chain.
3. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
4. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.
5. The deflection is the difference between these two measurements. If the deflection exceeds 3/4 in. (19 mm), timing chain should be replaced.



72376

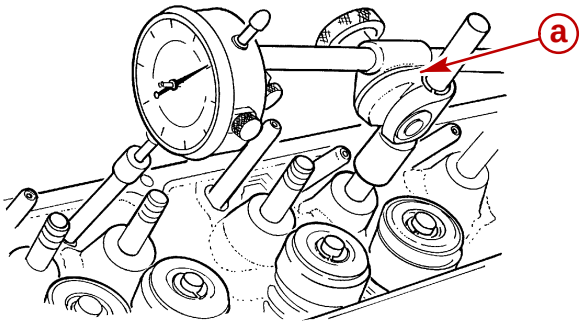
a - Reference Point

Camshaft

Measuring Lobe Lift

NOTE: *Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.*

1. Remove valve mechanism.
2. Position indicator with ball socket adaptor tool on push rod. Ensure that push rod is in lifter socket.



72380

a - Ball Socket Adapter Tool (J-8520-1)

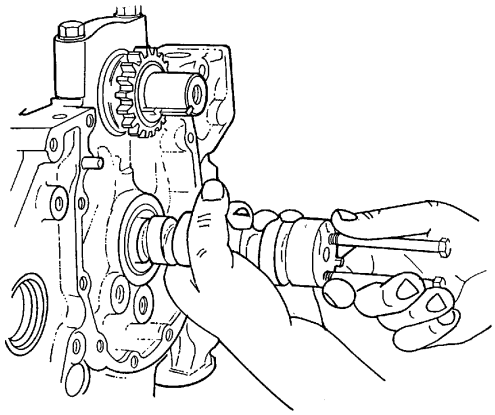
3. Rotate crankshaft torsional damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.

INDEX

4. Set dial indicator on zero, then rotate balancer slowly (or attach an auxiliary starter switch and “bump” engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with “Specifications.”
6. Continue to rotate engine until indicator reads zero. This will check accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install and adjust valve mechanism.

Removal

1. Remove valve lifters.
2. Remove crankcase front cover.
3. Remove fuel pump and fuel pump push rod.
4. Remove camshaft as follows:
   a. Remove timing chain and sprocket or timing gears as outlined.
   b. Remove camshaft thrust plate.
   c. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes and carefully remove camshaft as shown.



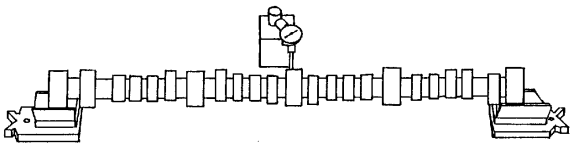
72381

Inspection

Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001 in. (0.025 mm) out-of-round, camshaft should be replaced.

Also check camshaft for alignment with V-blocks and dial indicator which indicates exact amount camshaft is out of true. If out of true more than .002 in. (0.051 mm) (dial indicator reading) camshaft should be replaced.

On engines with timing gears, inspect camshaft gear and thrust plate for wear and damage.



72382

Checking Camshaft Alignment

Installation

1. Install camshaft as follows:
   a. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes.
   b. Lubricate camshaft journals with engine oil and install camshaft. Be careful not to damage bearings.
   c. Lubricate camshaft lobes with General Motors Cam and Lifter Prelube or equivalent.
   d. Install camshaft thrust plate (retainer) and bolts. Torque the bolts to 106 lb-in. (12 Nm).
   e. Install timing chain or gears as outlined.
2. Install fuel pump push rod and fuel pump.
3. Install crankcase front cover and valve lifters as outlined.

Camshaft Bearings

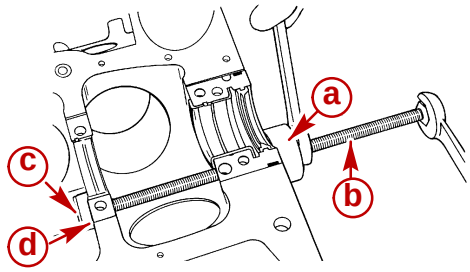
Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, fasten connecting rods against sides of engine so that they will not interfere while replacing camshaft bearings. Remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

NOTE: *This procedure is based on removal of bearings from center of engine first, thus requiring a minimum number of turns to remove all bearings.*

2. Install nut and thrust washer to end of threads on camshaft bearing remover and installer set (P/N J-6098-01).
3. Position pilot in front camshaft bearing.
4. Install puller screw through pilot.
5. Install tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
6. Using two wrenches, hold puller screw while turning nut.
7. Pull bearing bore.
8. Remove tool and bearing from puller screw.
9. Remove remaining bearings (except front and rear) in same manner.
10. Position pilot in rear camshaft bearing to remove rear intermediate bearing.

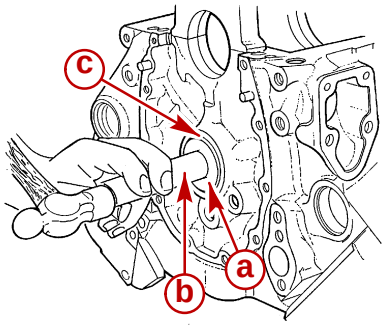


72383

a - Index Pilot
b - Puller Screw
c - Driver
d - Bearing

INDEX

11. Assemble driver on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block.



72384

a - Driver
b - Driver Handle
c - Bearing

Cleaning and Inspection

Clean camshaft bearing bores in cylinder block with solvent and blow out with compressed air. Be sure grooves and drilled oil passages are clean.

Installation

Front and rear bearings must be installed last as pilot will not fit into bearing bores if bearings are installed.

Lubricate outer surface of new camshaft bearings with engine oil to ease installation.

INDEXING BEARING

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearings in proper locations (Indicated by bearing manufacturer) and to position bearings as follows (directional references are in reference to engine in its normal operating position):

- **Front bearing must be positioned so that oil holes are equal distance from 6 o'clock position in the block. Intermediate and center bearings must be positioned so that oil holes are at the 5 o'clock position (toward left side of block and at a position even with bottom of cylinder bore). Rear bearing must be positioned so that oil hole is at the 12 o'clock position.**

INTERMEDIATE AND CENTER BEARINGS

1. Install nut and thrust washer onto puller screw.
2. Position pilot in front camshaft bearing bore and insert screw through pilot.
3. Index center camshaft bearing.
4. Position appropriate size removal and installation tool in bearing and thread puller screw into tool. Be sure at least 1/2 in. (13 mm) of threads are engaged.
5. Using two wrenches, hold puller screw and turn nut until bearing has been pulled into position.
6. Remove the removal and installation tool and ensure that oil hole(s) in bearing are positioned correctly.
7. Install intermediate bearings in same manner. Ensure bearings are indexed correctly. Position pilot in rear camshaft bearing bore to install rear intermediate bearing.

INDEX

FRONT AND REAR BEARINGS

1. Install appropriate size removal and installation tool on drive handle.
2. Index front bearing and drive it into position with tool.
3. Ensure bearing is positioned correctly. Index rear bearing and drive it into position with tool.
4. Install a new camshaft rear plug.

IMPORTANT: Plug must be installed flush to 1/32 in. (0.8 mm) deep and must be parallel with rear surface of cylinder block.

5. Install crankshaft and camshaft.

Cylinder Block

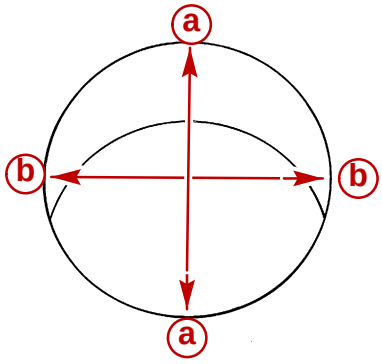
Cleaning and Inspection

1. Remove all engine components.
2. Wash cylinder block thoroughly in cleaning solvent.
3. Clean all gasket surfaces.
4. Remove oil gallery plugs.
5. Clean all oil passages.
6. Remove expansion plugs.

NOTE: *These plugs may be removed with a sharp punch, or they may be drilled and pried out.*

7. Clean and inspect water passages in cylinder block.
8. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.

9. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.



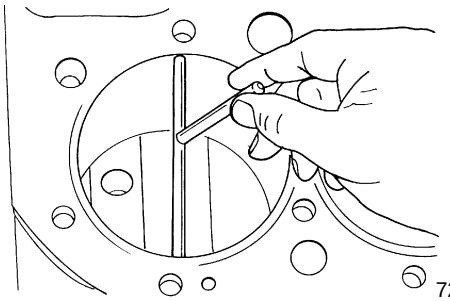
72385

Cylinder Measurement

a - At Right Angle To Centerline Of Engine
b - Parallel To Centerline Of Engine

"Out-of-Round" = Difference between "a" and "b"

"Taper" = Difference between measurement "a" at top of cylinder bore and "a" measurement at bottom of cylinder bore



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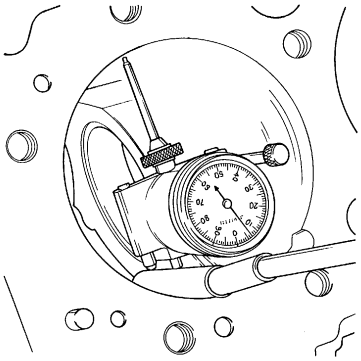

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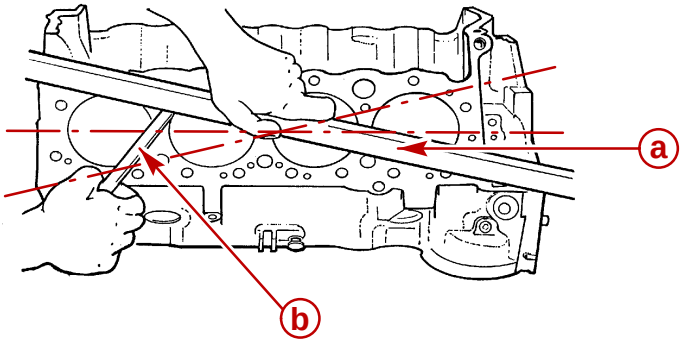
Measuring Cylinder Bore

10. Check cylinder head gasket surfaces for warp with a machinist's straight-edge and a feeler gauge. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are warped more than .003 in. (0.07 mm) in a 6 in. area or .007 in. (0.2 mm) overall, block must be resurfaced by a machine shop.



72388

a - Machinist's Straight-Edge
b - Feeler Gauge

INDEX

CYLINDER CONDITIONING

NOTE: *Performance of the following operation depends upon engine condition at time of repair.*

NOTE: *If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.*

1. If cylinders have less than .005 in. (0.127 mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of more than .005 in. wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to rebore for an oversize piston. If more than .005 in. taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
2. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING

IMPORTANT: Before using any type boring bar, file top of cylinder block to remove dirt or burrs. This prevents boring bar tilt caused by the rebored cylinder wall not being at right angles to crankshaft.

1. File top of cylinder block to remove dirt and burrs.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE: *Hone cylinders as outlined under "Cylinder Honing" and "Piston Selection," following.*

3. Carefully observe instructions furnished by manufacturer of equipment being used.

CYLINDER HONING

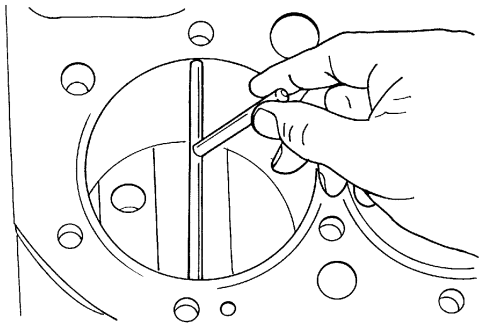
1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a crosshatch pattern of approximately 30 degrees to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings, cylinder bores and bearings lubricated by the contaminated oil. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
   a. Measure cylinder bore diameter with a telescope gauge 2-1/2 in. (64 mm) from top of cylinder bore as follows.



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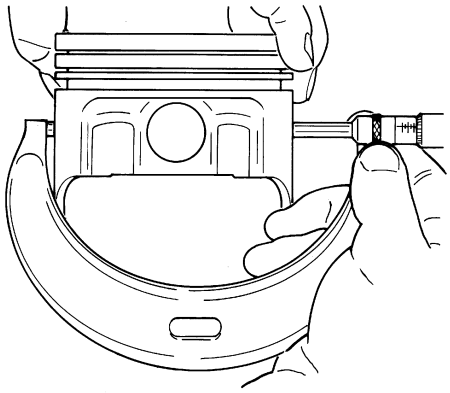
   b. Measure piston diameter at skirt across center line of piston pin as shown.



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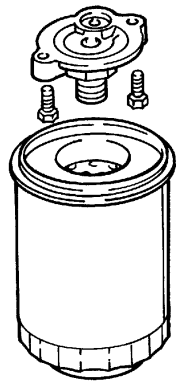
   c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.
   d. Determine if piston-to-bore clearance is in acceptable range shown in “Specifications.”
2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (acceptable range).
4. Mark piston to identify cylinder for which it was fitted.

Oil Filter By-Pass Valve and Adaptor Assembly



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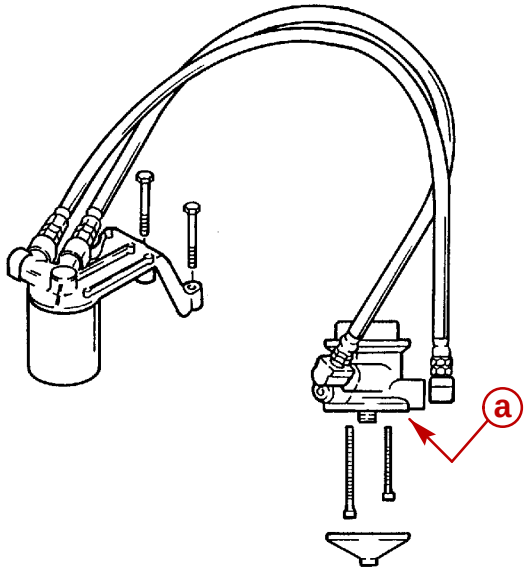
Without Remote Oil Filter



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With Remote Oil Filter

a - Fiber Valve

IMPORTANT: Oil by-pass valve and adaptor assembly should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

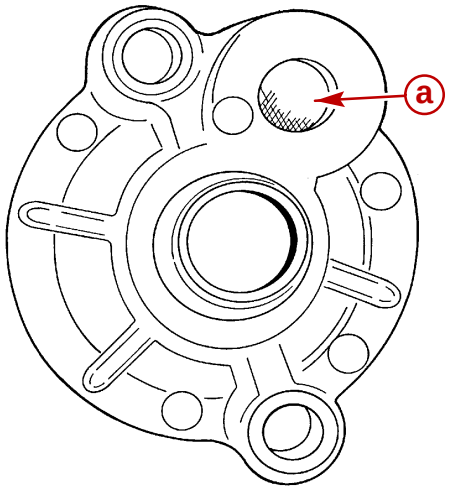
IMPORTANT: Refer to “Engine Parts List” when ordering parts for oil filter by-pass valve, adaptor assembly or remote oil filter parts.

Removal

1. Remove oil filter on engines with block mounted filter or cylinder block adaptor on engines with remote oil filter.
2. Remove by-pass valve and adaptor assembly.

Cleaning and Inspection

1. Clean by-pass valve and adaptor assembly in solvent and blow dry with compressed air.
2. Inspect fiber valve for cracks or other damage.
3. Ensure that valve fits tightly against its seat.
4. Push valve down and release it. Valve should return freely to its seat. If valve operation is questionable, by-pass valve and adaptor assembly should be replaced. Bypass valve may be replaced separately on remote filter assembly.



72391

Typical By-Pass Valve and Adaptor Assembly

a - Fiber Valve

5. Wipe out valve chamber in cylinder block to remove any foreign material.

Installation

1. Install by-pass valve and adaptor assembly or cylinder block adaptor to engine block. Tighten bolts to 20 lb-ft (27 Nm).
2. Lubricate oil filter rubber seal and install oil filter hand-tight only.

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ELECTRICAL SYSTEMS

Section 4E - Wiring Diagrams

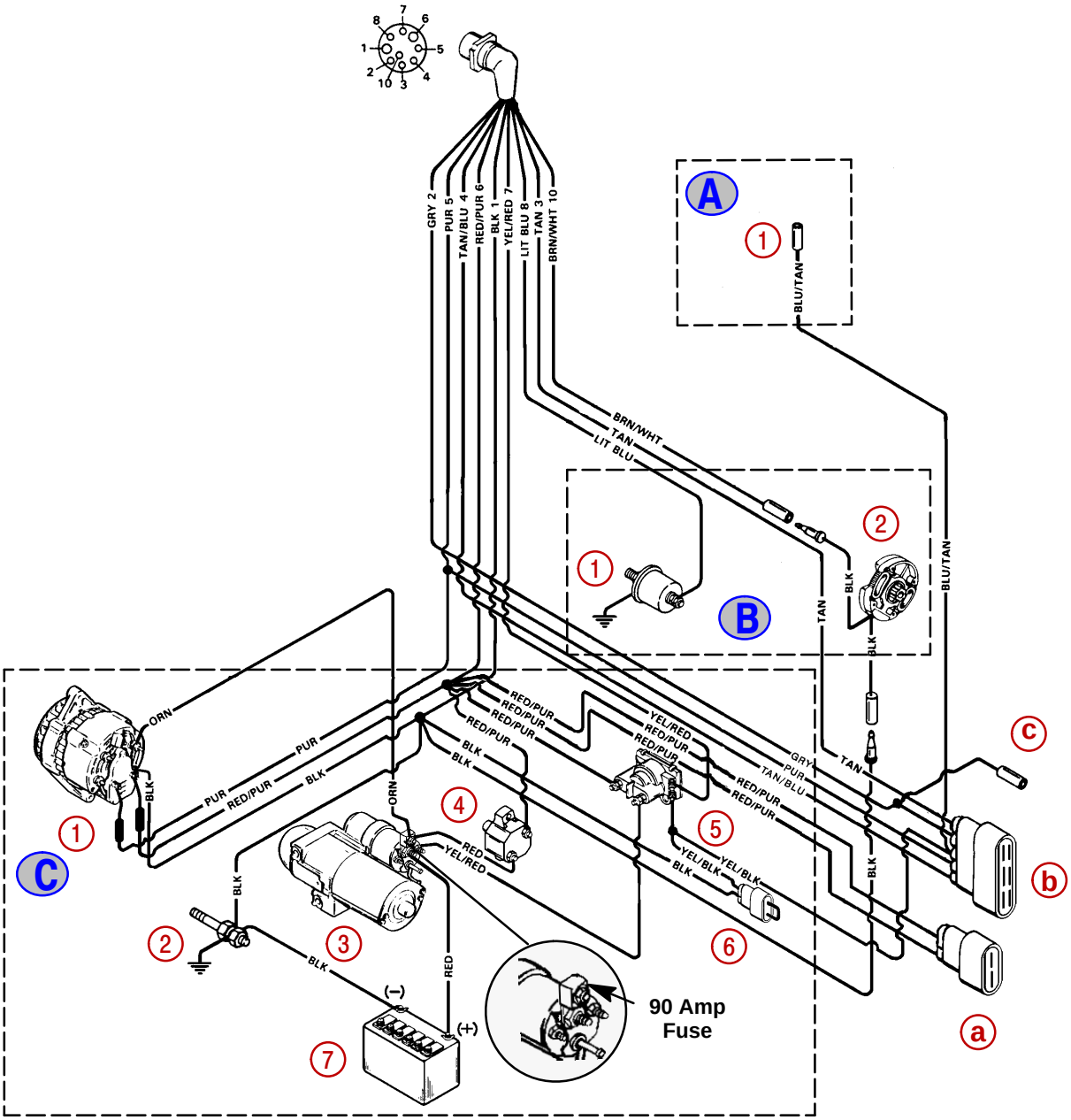
Table of Contents

Starting and Charging Harness 4E-2
MCM MX 6.2L MPI Engines 4E-2
MIE MX 6.2 MPI and MX 6.2 Black Scorpion Engines - 4E-4
Fuel and Ignition System Harness 4E-6
MX 6.2 MPI and MX 6.2 Black Scorpion Engines 4E-6

4 E

Starting and Charging Harness

MCM MX 6.2L MPI Engines



76061

INDEX

A - Audio Warning ComponentS

1 - Oil Pressure Switch

B - Instrumentation Components

1 - Oil Pressure Sender
2 - Trim Sender

C - Charging and Starting Components

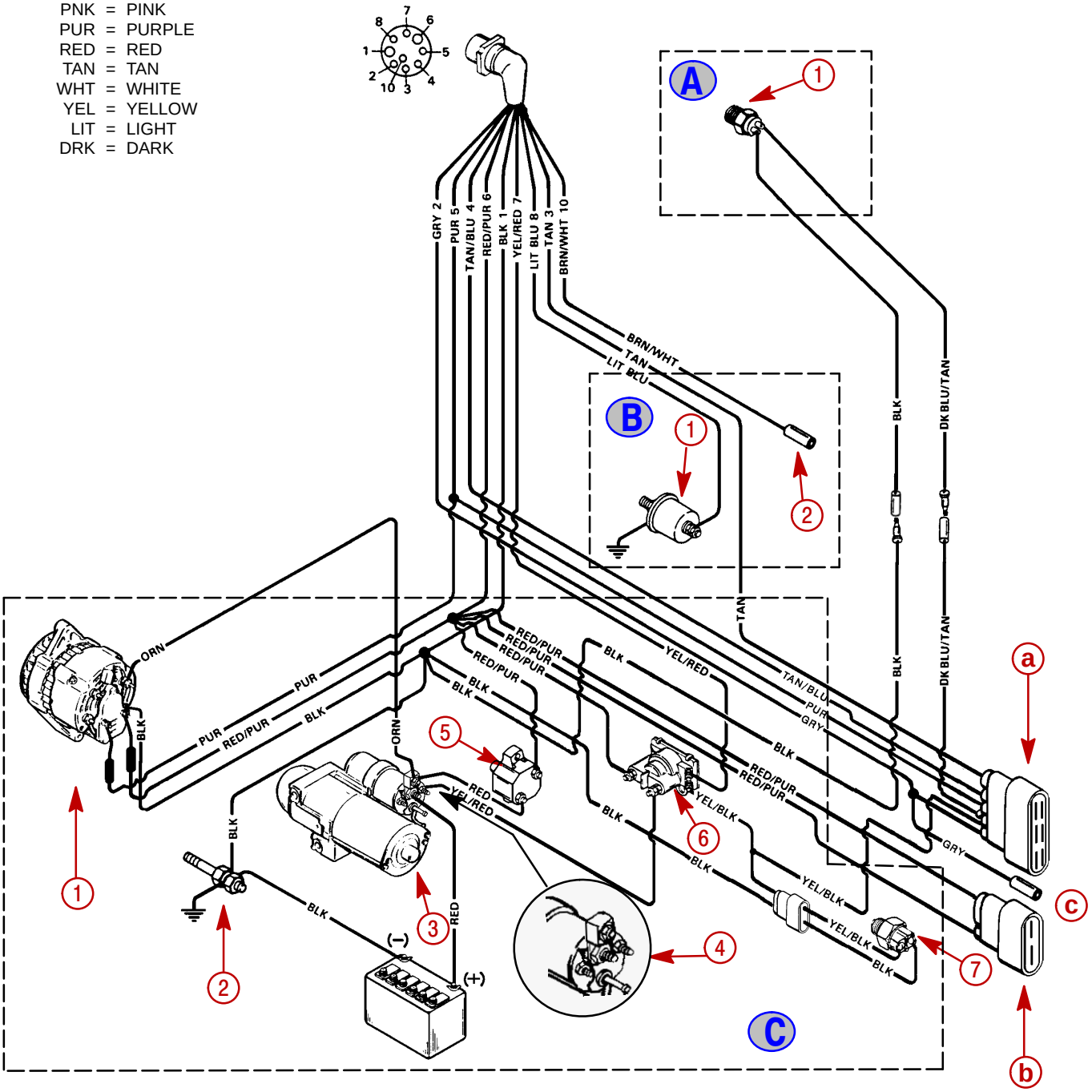
1 - Alternator
2 - Ground Stud
3 - Starter
4 - Circuit Breaker
5 - Starter Slave Solenoid
6 - Jumper Wire Connection
7 - Battery
a - Positive Power Wire To EFI System Harness
b - Harness Connector To EFI System Harness
c - Auxiliary Tachometer Lead

INDEX

MIE MX 6.2 MPI and MX 6.2 Black Scorpion Engines -

NOTE: *Taped back BROWN-WHITE wire may be used for an Accessory. LOAD MUST NOT EXCEED 5 AMPS.*

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK



A - Audio Warning Components

1 - Transmission Temperature Switch

B - Instrumentation Components

1 - Oil Pressure Sender
2 - Wire Not Used

C - Charging and Starting Components

1 - Alternator
2 - Ground Stud
3 - Starter
4 - 90 Amp Fuse (DO NOT REMOVE)
5 - Circuit Breaker
6 - Starter Slave Solenoid
7 - Neutral Safety Switch

a - Positive Power Wire To EFI System Harness
b - Harness Connector To EFI System Harness
c - Auxiliary Tachometer Lead

INDEX

Fuel and Ignition System Harness

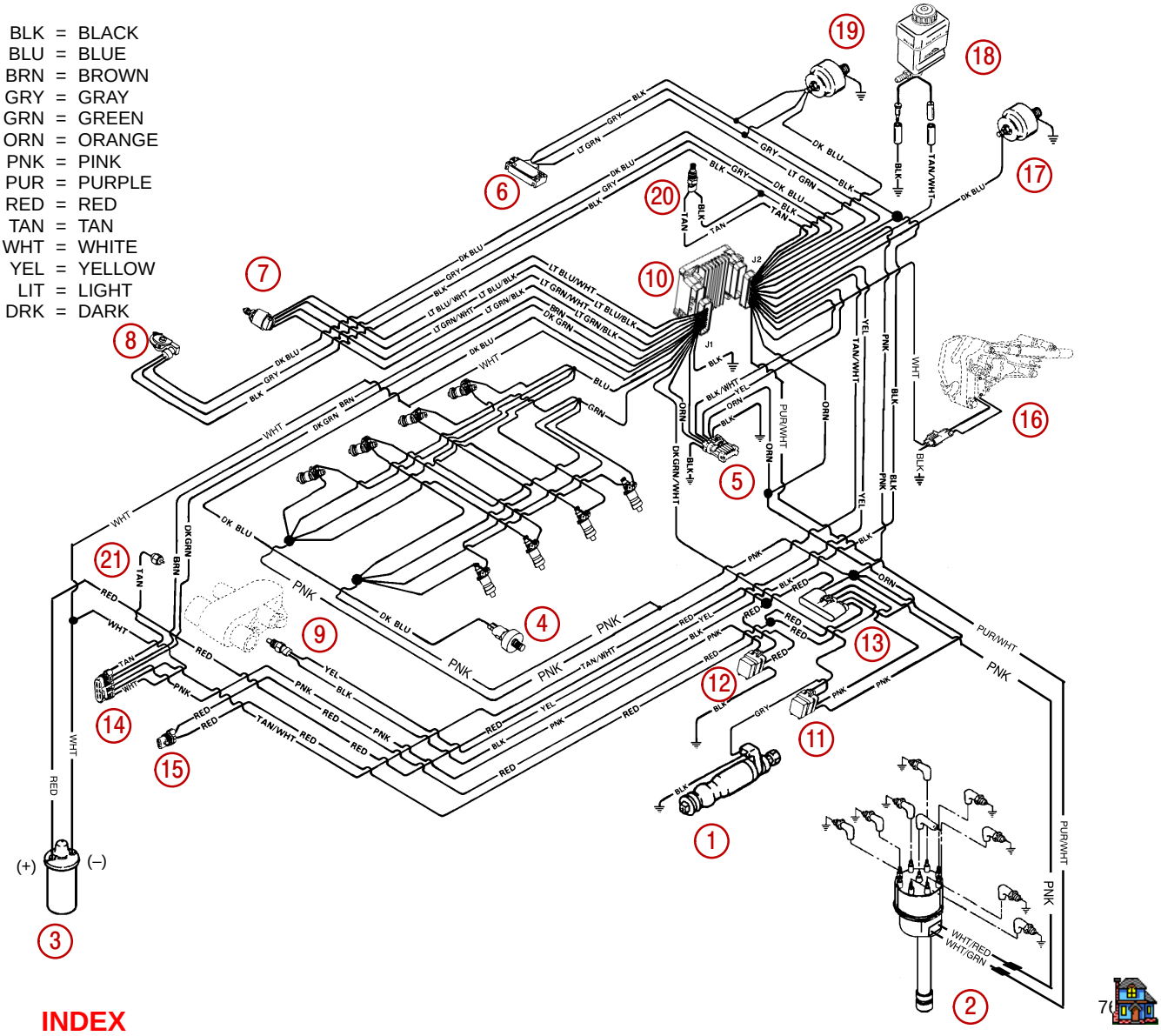
MX 6.2 MPI and MX 6.2 Black Scorpion Engines

NOTE: *All BLACK wires with a ground symbol are interconnected within the EFI system harness.*

NOTE: *Component position and orientation shown is arranged for visual clarity and ease of circuit identification.*

1 - Fuel Pump
2 - Distributor
3 - Coil
4 - Knock Sensor (KS) Module
5 - Data Link Connector (DLC)
6 - Manifold Absolute Pressure (MAP) Sensor
7 - Idle Air Control (IAC)
8 - Throttle Position (TP) Sensor
9 - Engine Coolant Temperature (ECT) Sensor
10 - Electronic Control Module (ECM)
11 - Fuel Pump Relay
12 - Ignition/System Relay
13 - Fuse (15 Amp) Fuel Pump, Fuse (15 Amp) ECM/DLC/Battery,Fuse (10 Amp) ECM/Injector/Ignition/Knock Module
14 - Harness Connector To Starting/Charging Harness
15 - Positive (+) Power Wire To Engine Circuit Breaker
16 - Shift Plate (Not used on MIE/SKI models)
17 - Oil Pressure (Audio Warning System)
18 - Gear Lube Bottle (Not used on Ski models)
19 - Fuel Pressure Switch
20 - Water Temperature Sender

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK



INDEX

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INDEX

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INDEX

FUEL SYSTEM

Section 5E - Fuel Injection Disassembly And Reassembly

Table of Contents

Service Precautions 5E-2
Specifications 5E-3
Torque Specifications 5E-3
Lubricants / Sealants / Adhesives 5E-3
Sensor Voltage 5E-3
Exploded Views - MX 6.2L MPI 5E-4
Flame Arrestor And Throttle Body 5E-4
Intake Manifold And Fuel Rail 5E-5
Fuel Pressure Relief Procedure 5E-6
MX 6.2 MPI Components 5E-6
Flame Arrestor 5E-6
Throttle Body 5E-8
Throttle Position Sensor 5E-11
Idle Air Control (IAC) Valve 5E-13
Knock Sensor 5E-15
Knock Sensor Module 5E-16
Fuel Pump Relay 5E-16
System Relay 5E-17
Electronic Control Module (ECM) 5E-17
Engine Coolant Temperature (ECT) Sensor 5E-18
Vacuum And Vent Hose Routing 5E-19
MX 6.2 MPI Models 5E-19
Exploded Views - MX 6.2 Black Scorpion Plenum, Throttle Body And Flame Arrestor 5E-20
Intake Manifold And Fuel Rails 5E-21
Fuel Pressure Relief Procedure 5E-22
MX 6.2 Black Scorpion Components 5E-22
Flame Arrestor 5E-22
Throttle Body 5E-24
Plenum 5E-28
Fuel Rails 5E-30
Fuel Injectors 5E-32
MAP Sensor 5E-33
Throttle Position Sensor 5E-34
Idle Air Control (IAC) Valve 5E-35
Knock Sensor 5E-37
Knock Sensor Module 5E-38
Fuel Pump Relay 5E-39
System Relay 5E-39
Engine Control Module 5E-40
Engine Coolant Temperature Sensor . 5E-41
Vacuum And Vent Hose Routing 5E-42
MX 6.2 Black Scorpion Models 5E-42

5 E

INDEX

Service Precautions

⚠ WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠ WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠ WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter(s). Wipe up any spilled fuel immediately.

⚠ WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

⚠ WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠ CAUTION

Fuel pressure MUST BE relieved before servicing high pressure components in the fuel system.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

The following information MUST BE adhered to when working on the fuel system:

- **Always keep a dry chemical fire extinguisher at the work area.**
- **Always install new O-rings when assembling fuel pipe fittings.**
- **DO NOT replace fuel pipe with fuel hose.**
- **DO NOT attempt any repair to the fuel system until instructions and illustrations relating to that repair are thoroughly understood.**
- **Observe all Warnings, Notes and Cautions.**

INDEX

Specifications

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Throttle Body Screws	75		8.5
Throttle Body on Adapter	89		10
Throttle Body on Plenum	75		8.5
TP Sensor And Dust Seal	20		2
IAC Valve	20		2
MAP Sensor	44-62		5-7
Knock Sensor		12-16	16-22
Black Scorpion Plenum	150		17
Fuel Rail Fasteners	105		12
Rail-to-Rail Fuel Line		18	24
Fuel Meter Cover Assembly Screws	28		3
Fuel Inlet and Return Lines		23	31
Engine Coolant Temperature Sensor	Tighten Hand Tight + 2 1/2 turns maximum		
Flame Arrestor Cover Bracket	Tighten Securely		
Flame Arrestor Clamp			

Lubricants / Sealants / Adhesives

Description	Part Number
Loctite 242	

Sensor Voltage

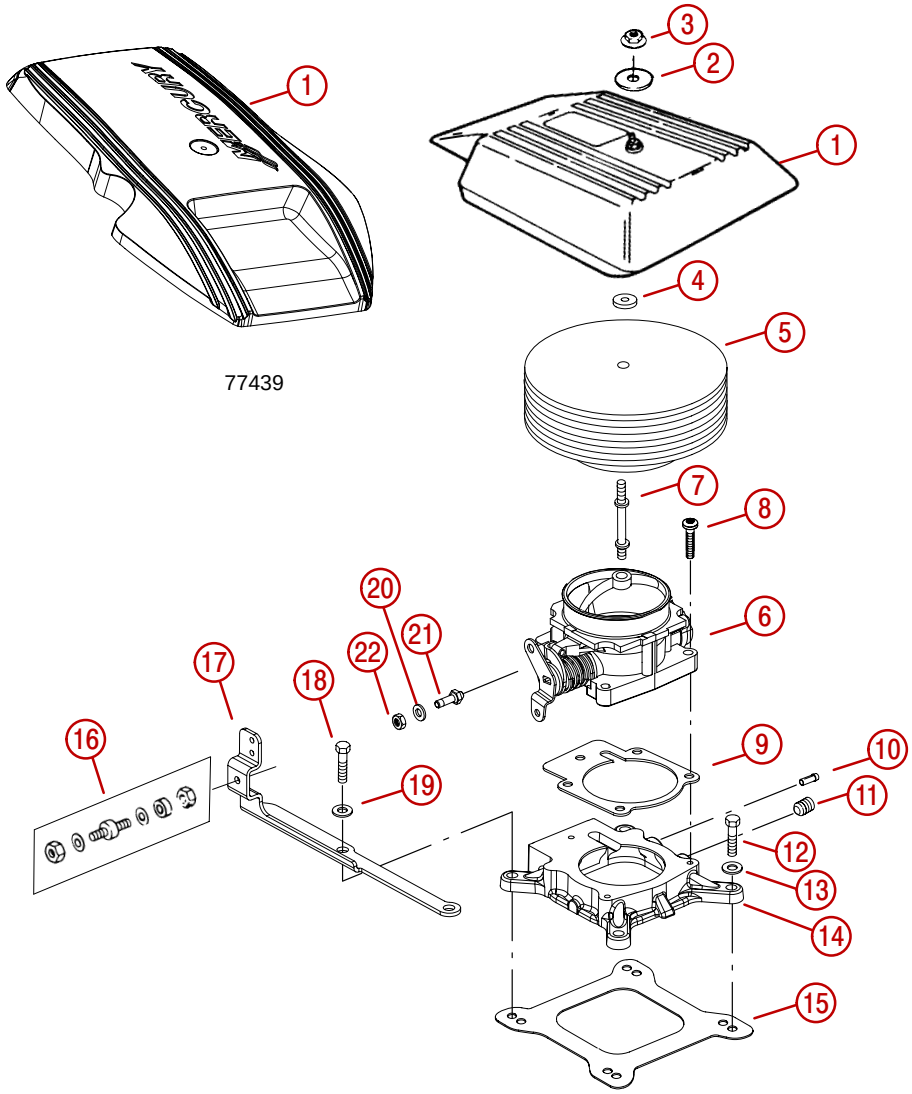
Description	Voltage at Idle	Voltage at WOT
Throttle Position (TP) Sensor	.7	4.5
Knock Sensor (KS)		
Engine Coolant Temperature (ECT) Sensor		
Manifold Absolute Pressure (MAP) Sensor		

INDEX

Exploded Views - MX 6.2L MPI

Flame Arrestor And Throttle Body

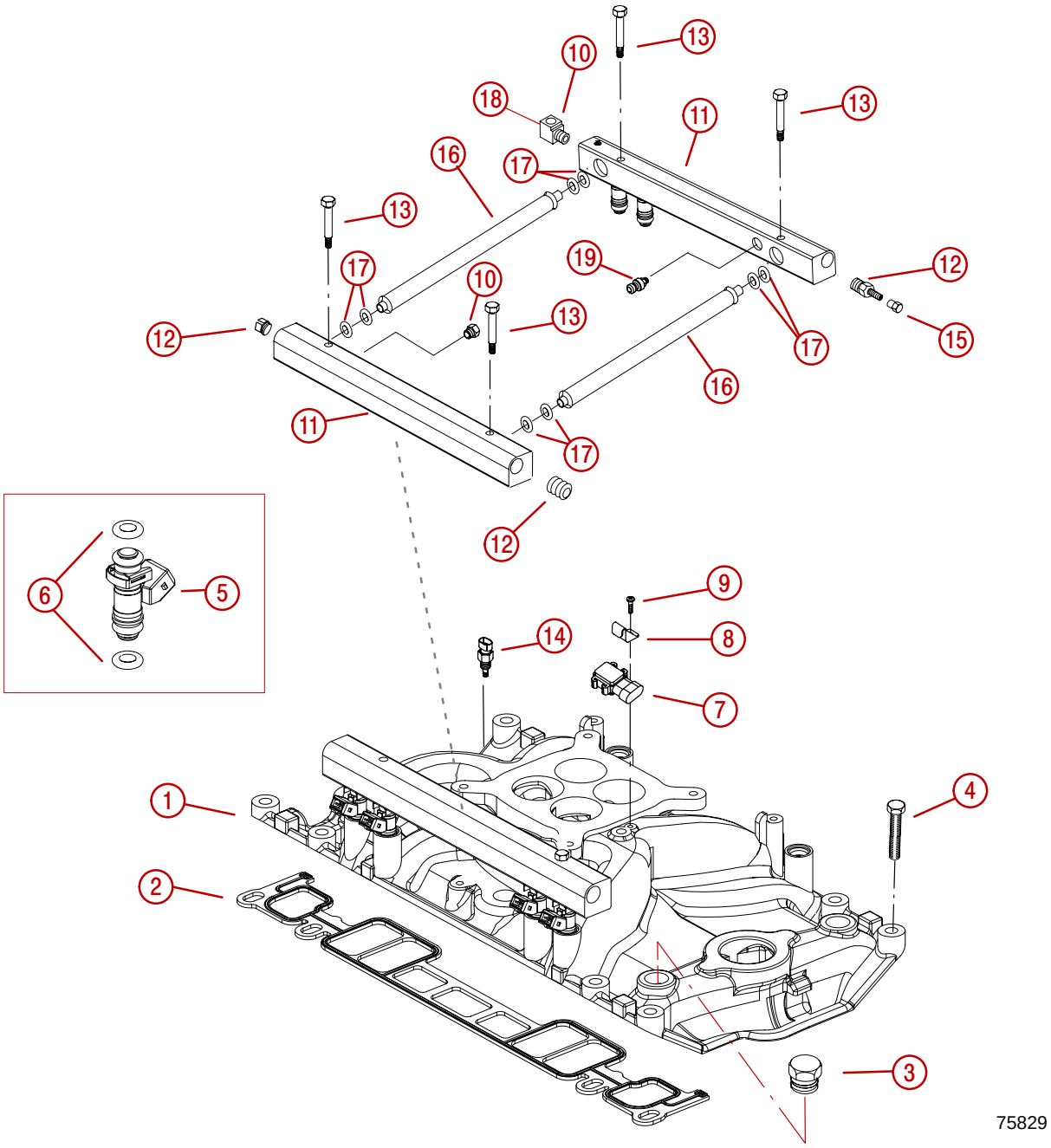
NOTE: *The 6.2L engine may be equipped with one of two covers. Both covers are shown below, but most pictures will show the early model cover.*



1 - Cover
2 - Washer
3 - Nut (1/4-28)
4 - Washer
5 - Flame Arrestor
6 - Throttle Body Assembly
7 - Stud
8 - Screw (1/4-20)
9 - Gasket
10 - 3/16 in. Barb Fitting (From Fuel Pressure Regulator)
11 - Pipe Plug (1/4-18 Socket Head)
12 - Screw [5/16-18 x 1-1/4 in. (32 mm)]
13 - Washer
14 - Throttle Body Adaptor Plate
15 - Gasket
16 - Stud Kit
17 - Throttle Cable Bracket
18 - Screw (5/16-18 x 1 in.)
19 - Washer
20 - Washer
21 - Stud (1/4 x 1-3/4 in.)
22 - Nut (1/4-28)

INDEX

Intake Manifold And Fuel Rail



1 - Intake Manifold
2 - Gasket
3 - Pipe Plug
4 - Screw [5/16-18 x1-3/8 in. (35 mm)]
5 - Fuel Injector
6 - O-Ring
7 - MAP Sensor
8 - Clip
9 - Screw [#8-32 x 1/4 in. (6 mm)]
10 - Pipe Plug (1/8 in. hex head)
11 - Fuel Rail
12 - Schrader Valve
13 - Screws (1/4-20 x 1-1/2 in.)
14 - MAT Sensor
15 - Cap
16 - Fuel Lines
17 - O-Rings
18 - Location of Fuel Line From Fuel Pump
19 - Pressure Sensor

INDEX

Fuel Pressure Relief Procedure

NOTICE
Refer to “Service Precautions,” at front of this section BEFORE proceeding.

1. Disconnect electrical connector at fuel pump.
2. Crank engine for ten seconds (if engine starts allow it run until it stops) to relieve any fuel pressure in the system.

MX 6.2 MPI Components

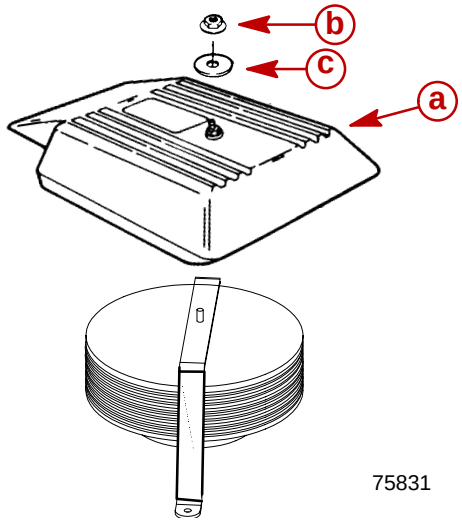
Flame Arrestor

NOTICE
Refer to “Service Precautions,” at front of this section BEFORE proceeding.

NOTE: *The 6.2L engine may be equipped with one of two covers. Both covers are shown below, but most pictures will show the early model cover.*

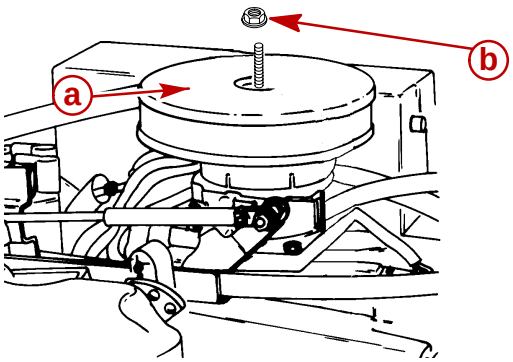
REMOVAL

1. Remove the flame arrestor cover.



a - Flame Arrestor Cover
b - Nut
c - Washer

2. Loosen the nut and remove the flame arrestor.



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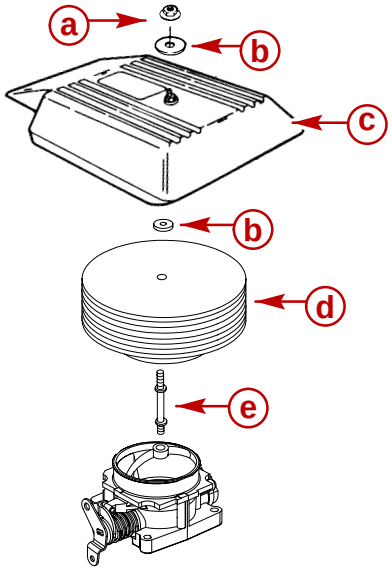
a - Flame Arrestor
b - Nut

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent.
2. Wear eye protection. Dry flame arrestor with compressed air.

INSTALLATION

1. Replace components as appropriate for your model. Tighten all fasteners securely.



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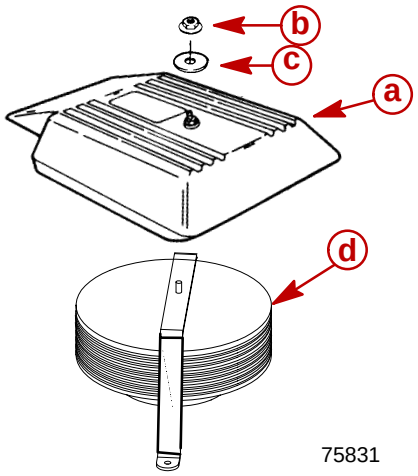
a - Nut
b - Washer
c - Flame Arrestor Cover
d - Flame Arrestor
e - Stud

2. Install flame arrestor cover. Secure with washer and locknut.



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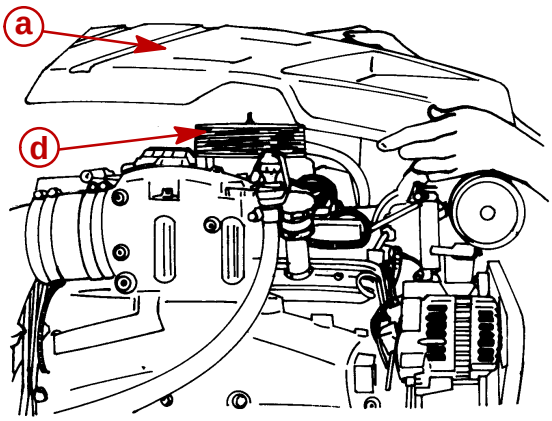

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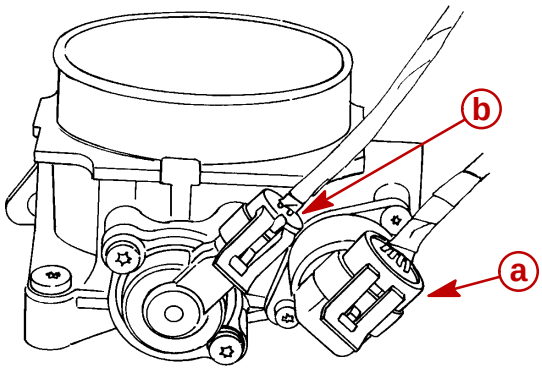
a - Flame Arrestor Cover
b - Nut
c - Washer
d - Flame Arrestor

Throttle Body

NOTICE
Refer to “Service Precautions,” at front of this section BEFORE proceeding.

REMOVAL

1. Remove the flame arrestor.
2. Disconnect the throttle linkage from the throttle body.
3. Disconnect the wiring connectors from the IAC valve and the TP sensor.

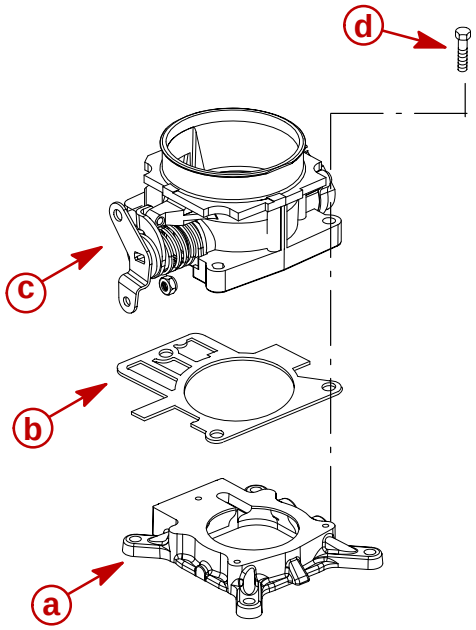


75788

a - IAC Valve Connector
b - Throttle Position Sensor Connector

INDEX

4. Remove the screws (3) retaining the throttle body and remove the throttle body from the adapter. Refer to “Exploded View”.



75828

a - Adapter
b - Gasket
c - Throttle Body
d - Screws

IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

CLEANING AND INSPECTION

IMPORTANT: DO NOT use cleaners containing methyl ethyl ketone. It is not necessary for cleaning throttle bore and valve deposits.

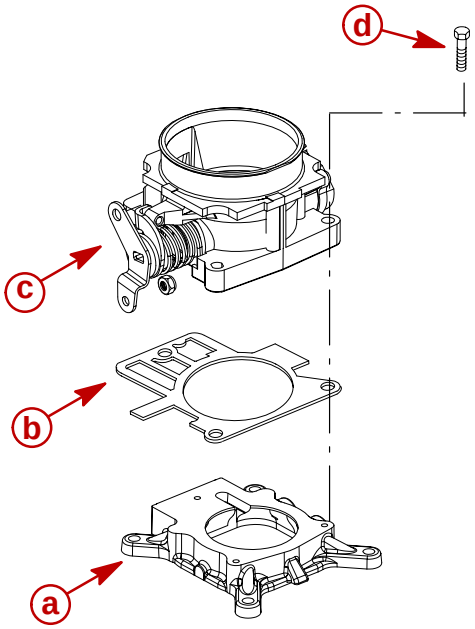
IMPORTANT: DO NOT allow the TP sensor and IAC valve to come into contact with solvent or cleaner.

IMPORTANT: Use care when removing gasket material from adapter and throttle body. Failure to do so could result in damage to the adapter and throttle body.

1. Carefully remove all gasket material from adapter and throttle body.
2. Thoroughly clean all parts of throttle body. Make certain that all passages are free of dirt and burrs.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect throttle body for cracks in casting.
5. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
6. Check adapter for loose parts and foreign material.

INSTALLATION

1. Place the throttle body gasket between the throttle body and the adapter.
2. Place the throttle body on the adapter. Install the screws and torque to 75 lb-in. (8.5 Nm).



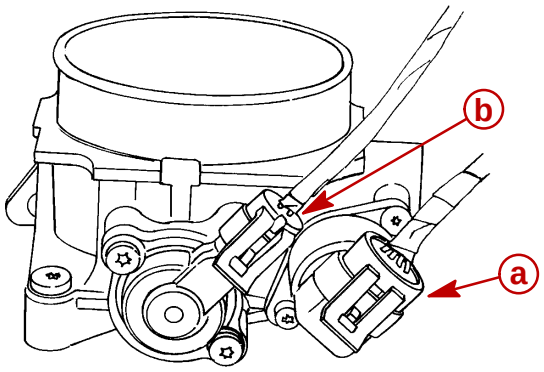
75828

Typical

- **a -** Adapter
- **b -** Gasket
- **c -** Throttle Body
- **d -** Screws

INDEX

3. Connect the harness connectors to the TP sensor and IAC valve.



75788

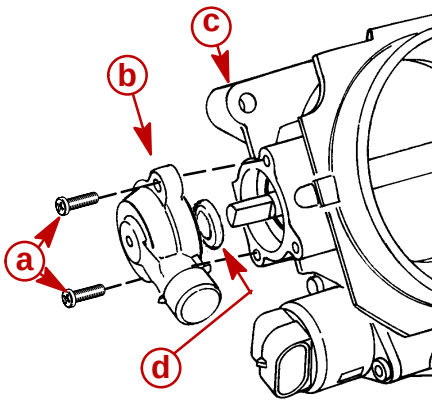
a - IAC Valve Connector
b - Throttle Position Sensor Connector

4. Connect the throttle cable to the throttle lever. Refer to SECTION 2 for throttle cable adjustment.
5. Install the flame arrestor.
6. Install the flame arrestor cover.

Throttle Position Sensor

NOTICE
Refer to "Service Precautions," in front of this section BEFORE proceeding.

1. Remove the flame arrestor cover.
2. Remove the flame arrestor from the throttle body.
3. Disconnect the harness connector from the TP sensor.
4. Remove the throttle body from the adapter.
5. Disconnect the harness connector from the TP sensor.
6. Remove the screws from the TP sensor.
7. Remove the TP sensor from the throttle body.



75832

a - Screw (2)
b - Throttle Position (TP) Sensor
c - Throttle Body
d - Dust Seal

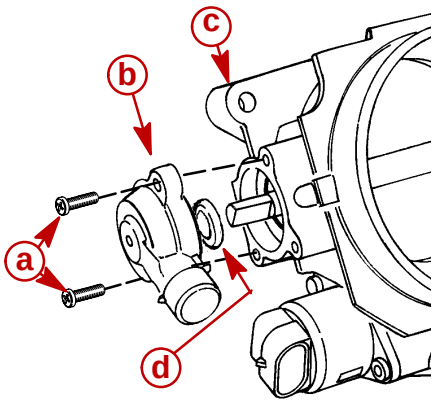
INDEX

CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the sensor for signs of wear or damage.

INSTALLATION

1. Apply Loctite 242 to screw threads. Install the TP sensor and dust seal on the throttle body using the screws. Torque screws to 20 lb-in. (2 Nm).



75832

a - Screw (2)
b - Throttle Position (TP) Sensor
c - Throttle Body
d - Dust Seal

2. Place a new gasket on the adapter.
3. Install throttle body on the adapter. Torque screws to 89 lb-in. (10 Nm).
4. Connect the harness connector to the TP sensor.
5. Place the flame arrestor over the throttle body and tighten clamp securely.
6. Install the flame arrestor cover. Tighten nut securely.
7. When negative (–) battery cable has been reconnected, start engine and check for TP sensor output voltage. It should be approximately .7 Volts at idle and 4.5 Volts at wide open throttle.

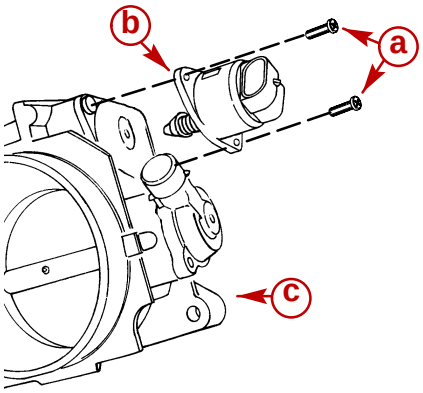
INDEX

Idle Air Control (IAC) Valve

NOTICE
Refer to “Service Precautions,” in front of this section BEFORE proceeding.

REMOVAL

1. Remove the flame arrestor, throttle cable and throttle body.
2. Remove the IAC valve from the throttle body.



75657

a - Screw (2)
b - Idle Air Control (IAC) Valve
c - Throttle Body

CLEANING AND INSPECTION

IMPORTANT: Do not push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle.

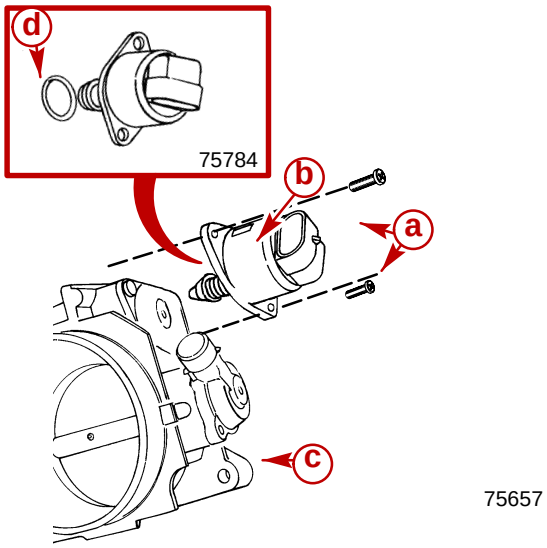
NOTE: *Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.*

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with an identical part. IAC valve pintle shape and diameter are designed for the specific application.

1. Install new O-ring on IAC valve.



a - Screw (2)
b - Idle Air Control (IAC) Valve
c - Throttle Body
d - O-Ring

2. Install IAC valve in throttle body using screws. Torque to 20 lb-in. (2 Nm).
3. Place a new gasket between throttle body and adapter.
4. Install the throttle body on the adapter and torque the screws to 89 lb-in. (10 Nm).
5. Reset IAC valve pintle position as follows:
   a. Turn ignition key ON for ten seconds.
   b. Turn ignition key OFF for ten seconds.
   c. Restart engine and check for proper idle operation.

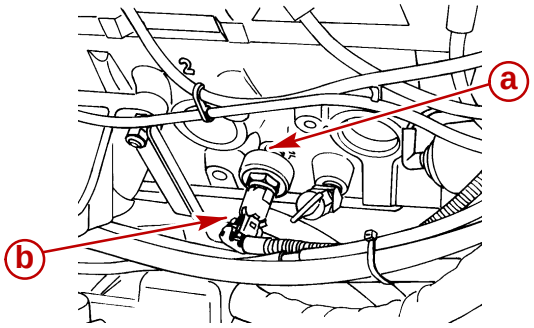
INDEX

Knock Sensor

NOTICE
Refer to “Service Precautions” in front of this section BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



75678

Starboard Side Shown

a - Knock Sensor
b - Electrical Connector

2. Remove knock sensor from engine block.

CLEANING AND INSPECTION

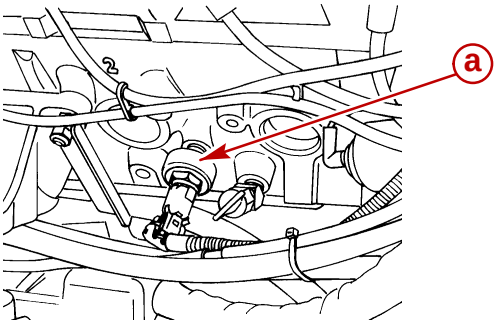
1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

INSTALLATION

IMPORTANT: If installing a new Knock Sensor, be sure to replace it with an identical part. Knock Sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the Knock Sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. DO NOT use sealer on threads.

1. Install knock sensor in engine block. Torque to 12-16 lb-ft (16-22 Nm).



75678

Starboard Side Shown

a - Knock Sensor

2. Connect electrical connector to knock sensor.

Knock Sensor Module

1. Remove the knock sensor module from the electrical bracket.
2. Disconnect electrical connector at knock sensor (KS) module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

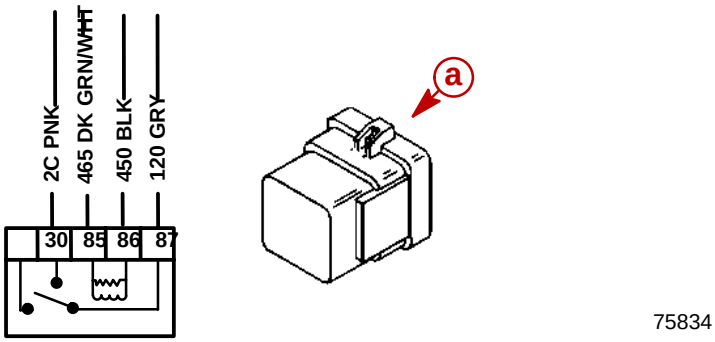
INSTALLATION

1. Mount KS module on bracket.
2. Connect electrical connector to the KS module.

Fuel Pump Relay

REMOVAL

1. Remove fuel pump relay from electrical bracket.



a - Fuel Pump Relay

2. Disconnect electrical connector and remove fuel pump relay.

CLEANING AND INSPECTION

IMPORTANT: The fuel pump relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

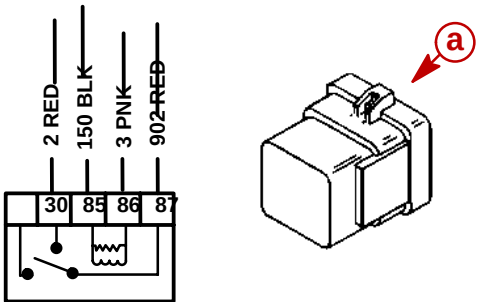
INSTALLATION

1. Connect electrical connector to fuel pump relay.
2. Attach fuel pump relay to bracket.

System Relay

REMOVAL

1. Remove system relay from electrical bracket.



a - System Relay

2. Disconnect electrical connector and remove relay.

CLEANING AND INSPECTION

IMPORTANT: The system relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

INSTALLATION

1. Attach electrical connector to relay.
2. Place system relay in electrical box.

Electronic Control Module (ECM)

NOTICE
Refer to “Service Precautions” in front of this section BEFORE proceeding.

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. DO NOT touch connector pins when removing or installing the module.

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM). DO NOT touch connector pins when removing.
2. Remove ECM from electrical bracket.

CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed out of the harness.

NOTE: *The ECM is a sealed electrical component. If a Code 51or 52 check has shown it to be defective, replace the unit with another ECM having the same part number as the original.*

INDEX

INSTALLATION

1. Mount new ECM to electrical bracket using screws and washers.
2. Connect J1 and J2 electrical connectors to the ECM. DO NOT touch connector pins when installing.

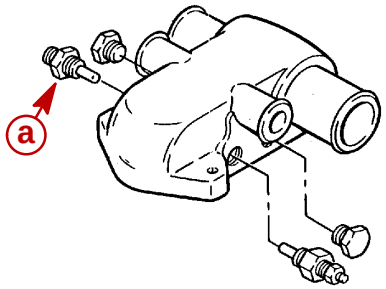
Engine Coolant Temperature (ECT) Sensor

NOTICE
Refer to “Service Precautions” in front of this section BEFORE proceeding.

REMOVAL

NOTE: *Handle the ECT carefully as any damage to it will affect operation of the system.*

1. Disconnect electrical connector at engine coolant temperature (ECT) sensor.



72799

a - Engine Coolant Temperature (ECT) Sensor

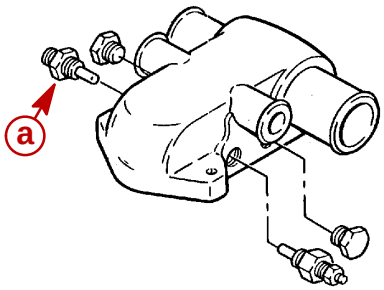
2. Remove ECT sensor from thermostat housing.

CLEANING AND INSPECTION

1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT sensor.

INSTALLATION

1. Install ECT sensor. Tighten hand tight plus 2-1/2 turns maximum.



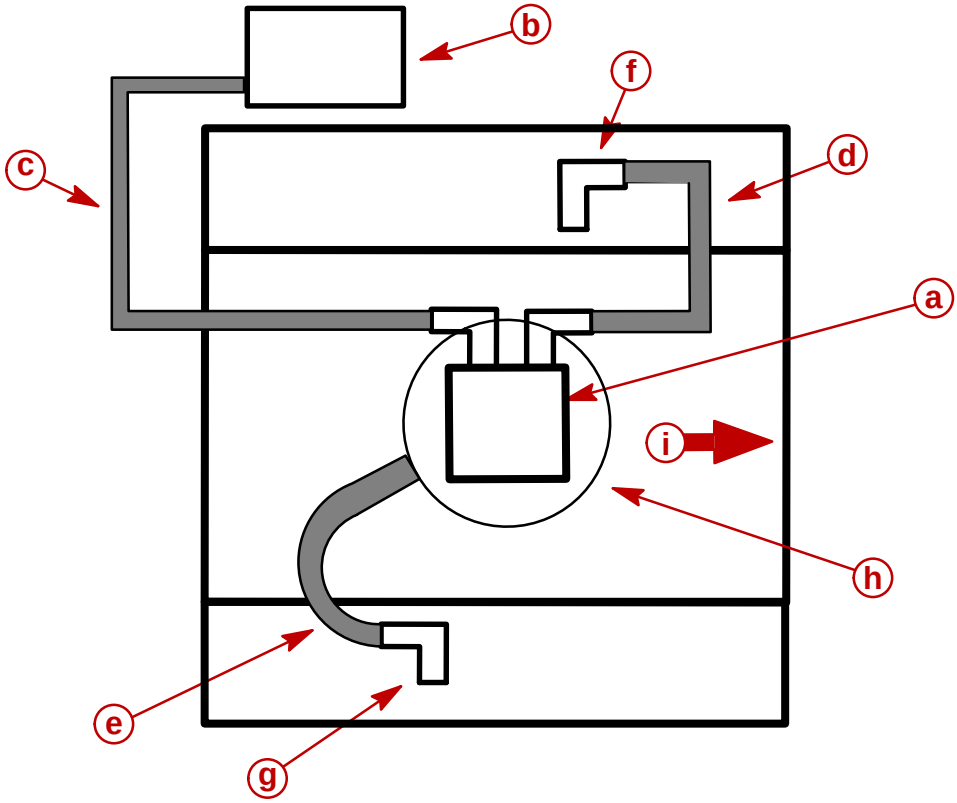
72799

a - Engine Coolant Temperature (ECT) Sensor

2. Connect electrical connector to ECT sensor.

Vacuum And Vent Hose Routing

MX 6.2 MPI Models

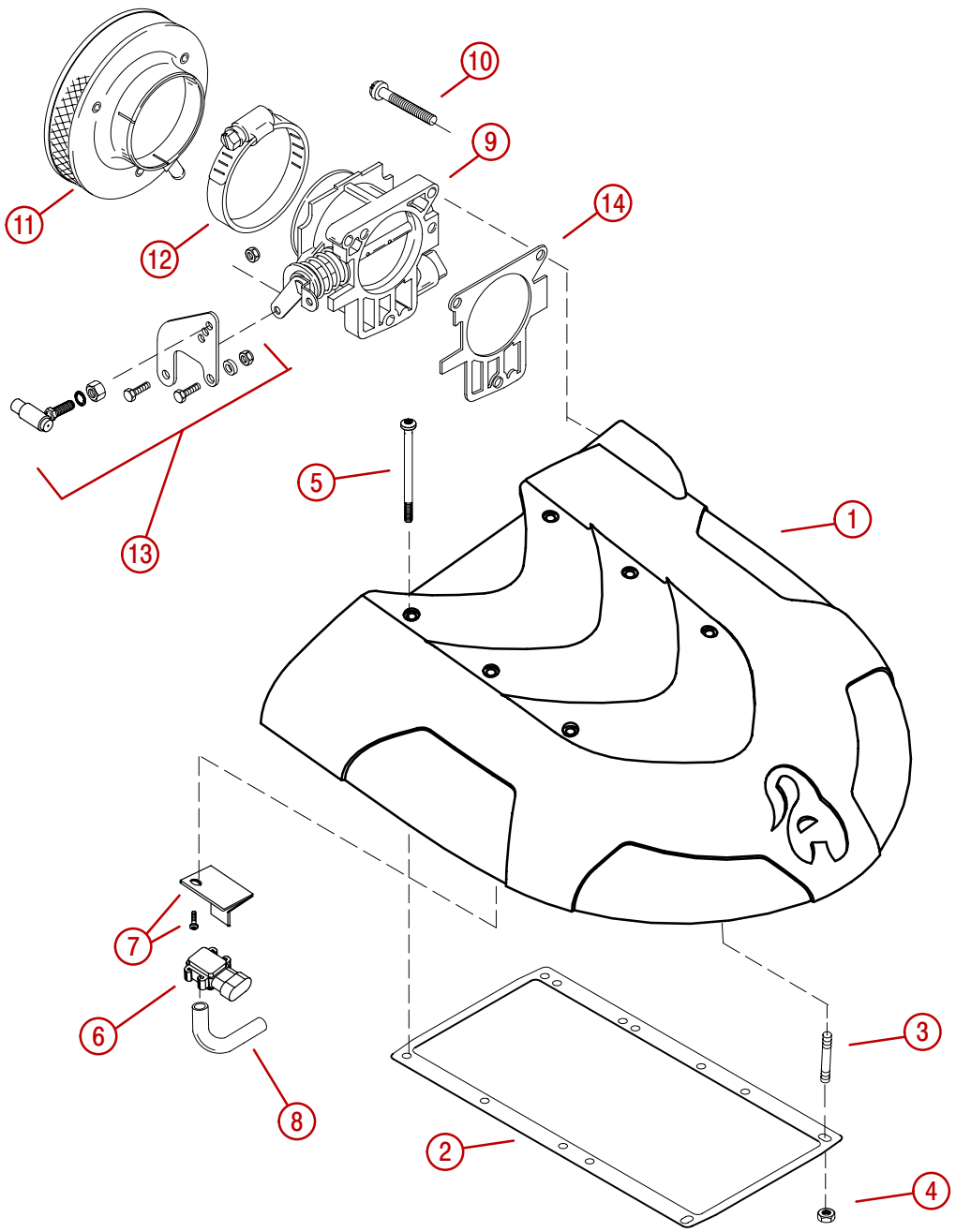


75837

a - Throttle Body Adapter
b - Cool Fuel Assembly
c - Vacuum Hose - Throttle Body Adapter to Fuel Pressure Regulator on Cool Fuel Assembly
d - Vent Hose - PCV Valve to Throttle Body Adapter
e - Vent Hose - Valve Cover Fitting To Flame Arrestor
f - PCV Valve
g - Vacuum Hose - T-Fitting to Plenum
h - Flame Arrestor
i - Front of Engine

Exploded Views - MX 6.2 Black Scorpion

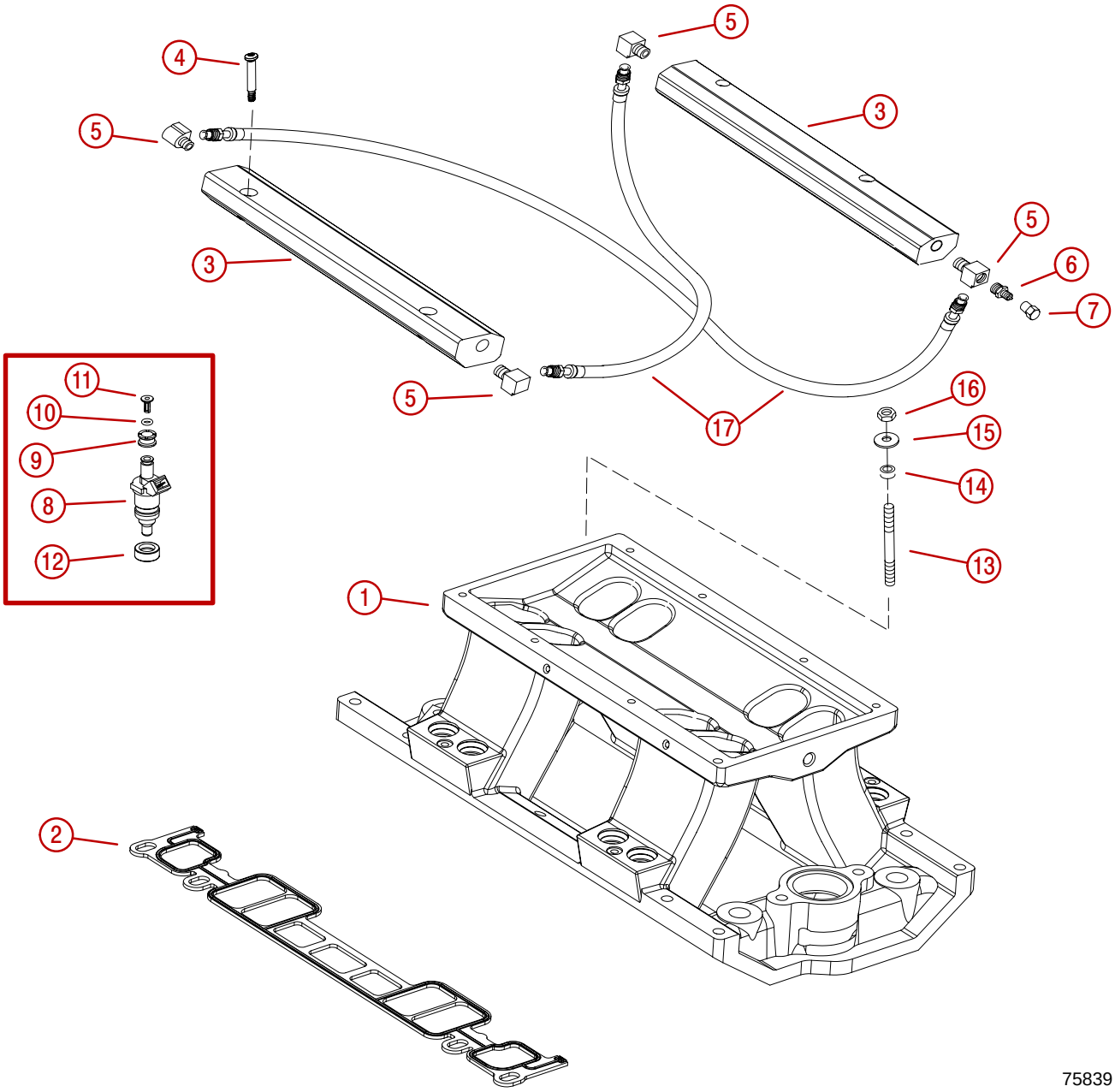
Plenum, Throttle Body And Flame Arrestor



1 - Intake Plenum
2 - Gasket
3 - Stud
4 - Nut (2)
5 - Plenum Screw
6 - MAP Sensor
7 - Screw and Bracket
8 - Hose
9 - Throttle Body
10 - Screw
11 - Flame Arrestor
12 - Clamp
13 - Throttle Lever and Linkage
14 - Gasket - See Changes Previously

INDEX

Intake Manifold And Fuel Rails



1 - Intake Manifold
2 - Intake Gasket (2)
3 - Fuel Rail (2)
4 - Screw
5 - Connector Fittings
6 - Schrader Valve
7 - Cap
8 - Fuel Injector
9 - Upper Seal
10 - O-Ring
11 - Screen
12 - Lower Seal
13 - Stud
14 - Spacer
15 - Washer
16 - Nut
17 - Fuel Lines

INDEX

Fuel Pressure Relief Procedure

NOTICE
Refer to “Service Precautions” in front of this section BEFORE proceeding.

1. Disconnect electrical connector at fuel pump.
2. Crank engine for ten seconds (if engine starts allow it run until it stops) to relieve any fuel pressure in the system.

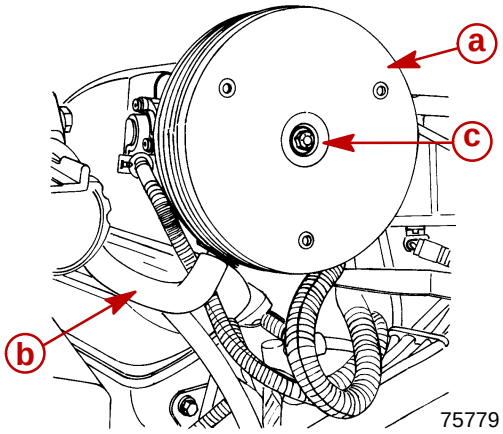
MX 6.2 Black Scorpion Components

Flame Arrestor

NOTICE
Refer to “Service Precautions” in front of this section BEFORE proceeding.

REMOVAL

1. Remove flame arrestor and related components.
2. Remove nut.
3. Remove crankcase ventilation hose from against flame arrestor and rocker arm cover fittings.
4. Remove flame arrestor.



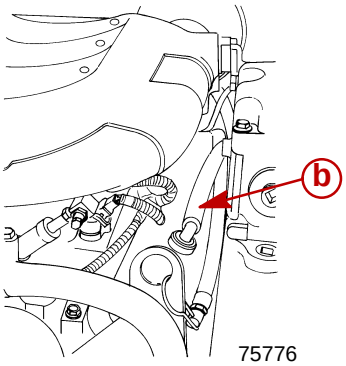
a - Flame Arrestor
b - Vent Hose
c - Nut (Later Style)

CLEANING AND INSPECTION

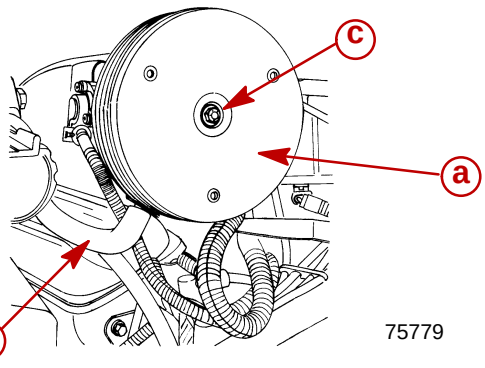
1. Clean flame arrestor in solvent. Blow dry with compressed air or allow to air dry completely.
2. Clean crankcase ventilation hoses in solvent. Blow dry with compressed air or allow to air dry completely.
3. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.

INSTALLATION

1. Install flame arrestor.
2. Tighten nut.
3. Position crankcase ventilation hose against flame arrestor and attach to rocker arm cover fittings.



75776



75779

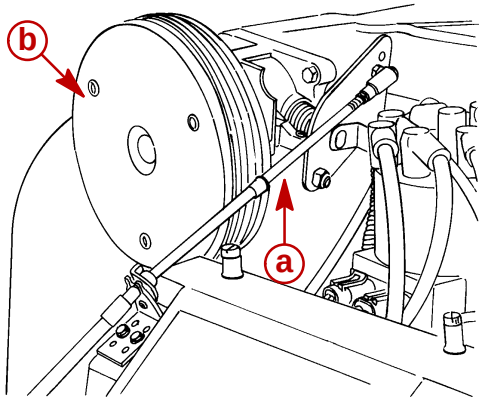
a - Flame Arrestor
b - Vent Hose
c - Nut (Later Style)

Throttle Body

NOTICE
Refer to “Service Precautions” in front of this section BEFORE proceeding.

REMOVAL

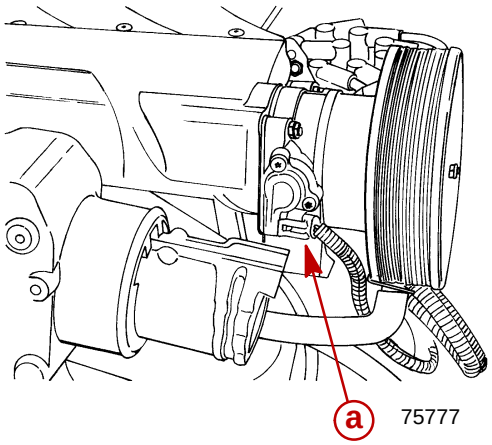
1. Remove the flame arrestor.
2. Disconnect the throttle cable from the throttle lever.



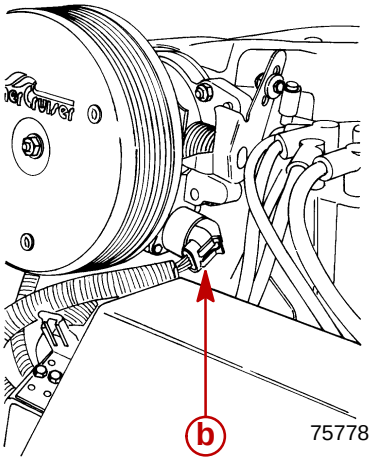
74838

a - Throttle Cable
b - Flame Arrestor

3. Disconnect the wiring connectors from the IAC valve and the TP sensor.



75777

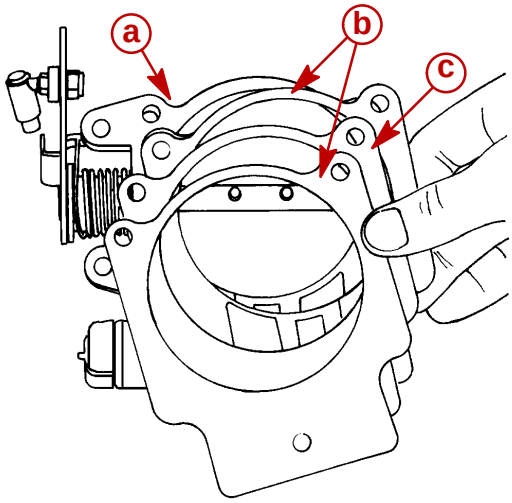


75778

a - Throttle Position Sensor Connector
b - IAC Valve Connector

INDEX

4. Remove the hardware retaining the throttle body and remove the throttle body from the adapter. Refer to “Exploded View.”



75783

a - Throttle Body
b - Gaskets
c - Plate

IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

CLEANING AND INSPECTION

IMPORTANT: DO NOT use cleaners containing methyl ethyl ketone. It is not necessary for cleaning throttle bore and valve deposits.

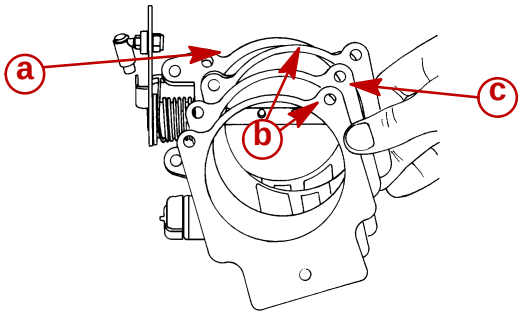
IMPORTANT: DO NOT allow the TP sensor and IAC valve to come into contact with solvent or cleaner.

IMPORTANT: Use care when removing gasket material from plenum and throttle body. Failure to do so could result in damage to the plenum and throttle body.

1. Carefully remove all gasket material from plenum and throttle body.
2. Thoroughly clean all parts of throttle body. Make certain that all passages are free of dirt and burrs.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect throttle body for cracks in casting.
5. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
6. Check for loose parts and foreign material.

INSTALLATION

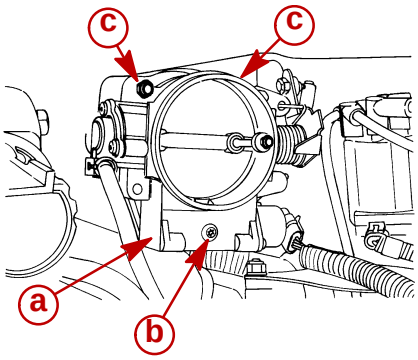
1. Place the throttle body gasket (s) between the throttle body and the plenum.



75783

a - Throttle Body
b - Gaskets
c - Plate

2. Place the throttle body on the plenum. Install the screw and nuts and torque to 75 lb-in. (8.5 Nm).

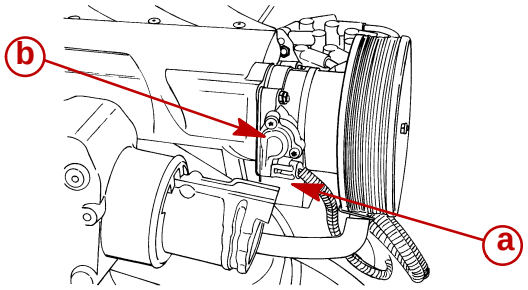


75781

a - Throttle Body
b - Screw
c - Nuts

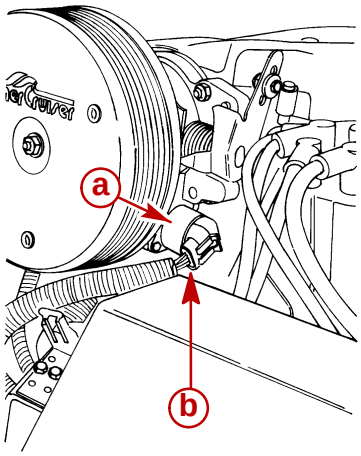
INDEX

3. Connect the harness connectors to the TP sensor and IAC valve.



75777

a - TP Sensor
b - Connector



75778

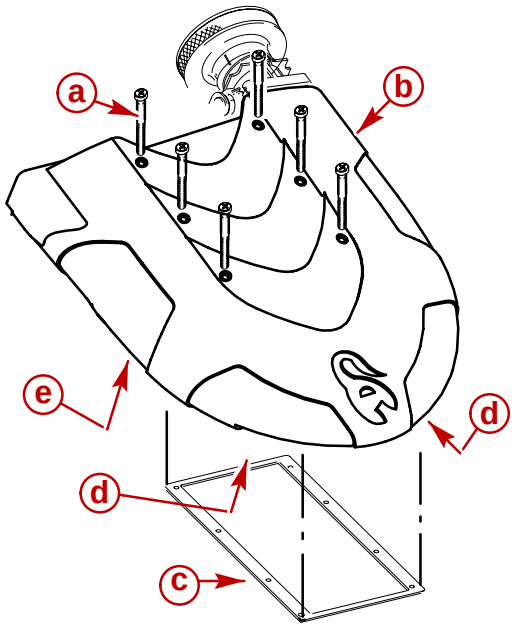
a - IAC Valve
b - Connector

4. Connect the throttle cable to the throttle lever. Refer to SECTION 2 for throttle cable adjustment.
5. Install the flame arrestor.

Plenum

REMOVAL

1. Disconnect the throttle cable.
2. Disconnect the harness connector and the vacuum hose from the MAP sensor. The sensor is located on the underside of the plenum on the starboard side.
3. Remove the screws retaining the intake plenum to the manifold. Remove the two nuts from the underside of the plenum in the front. Remove the plenum and gasket.



75710

a - Screws (6)
b - Plenum
c - Gasket
d - Nuts
e - MAP Sensor Location

CLEANING AND INSPECTION

IMPORTANT: Use care when removing gasket material from intake manifold and plenum. Failure to do so could result in damage to the intake manifold and plenum.

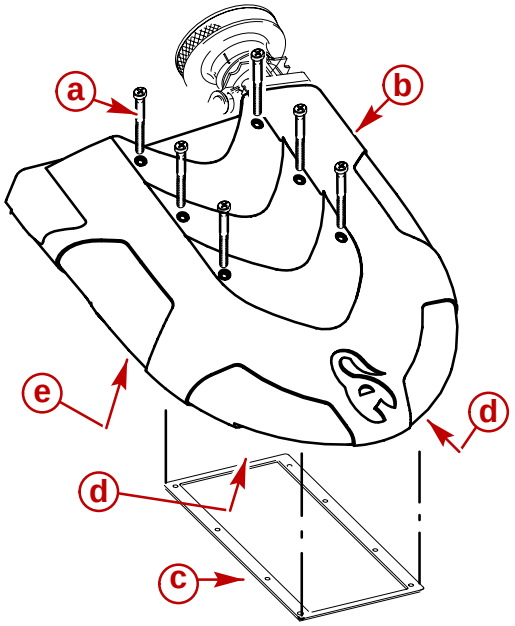
1. Carefully remove all gasket material from intake manifold and plenum.
2. Clean plenum in solvent and dry with compressed air.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect plenum for cracks in casting.

INSTALLATION

1. If not previously accomplished, remove all old gasket material.
2. Position the new plenum gasket on the intake manifold. The word “FRONT” faces UP on the gasket at front edge of the intake manifold.
3. Place the plenum over the gasket.
4. Install the the screws retaining the intake plenum to the manifold. Install the two nuts on the underside of the plenum in front.

INDEX

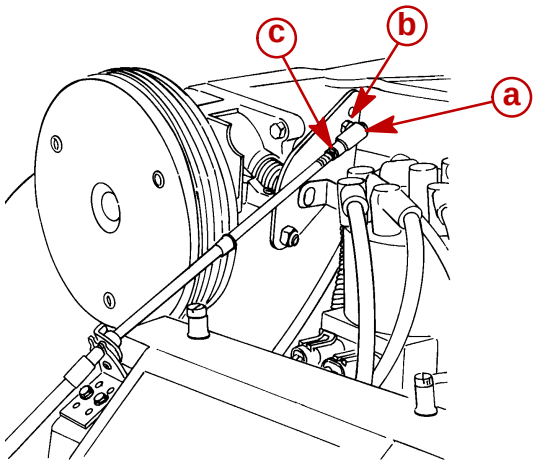
5. Torque the fasteners evenly in a diagonal pattern to 150 lb-in. (17 Nm).



75710

a - Screws (6)
b - Plenum
c - Gasket
d - Nuts
e - MAP Sensor Location

6. Place remote control throttle lever in idle position. Attach cable to throttle lever stud. Refer to SECTION 2 for throttle cable adjustment.
7. After throttle cable is adjusted, tighten locknut against cable end.



74838

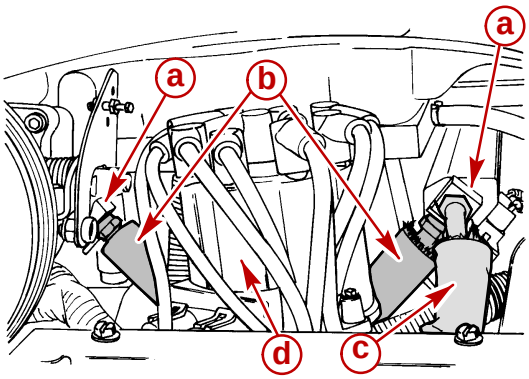
a - Cable End
b - Throttle Lever Stud
c - Locknut

8. Connect the harness connector and the vacuum hose to the MAP sensor.

Fuel Rails

REMOVAL

1. Remove distributor cap.
2. Disconnect fuel lines from aft end fuel rail connector fittings.

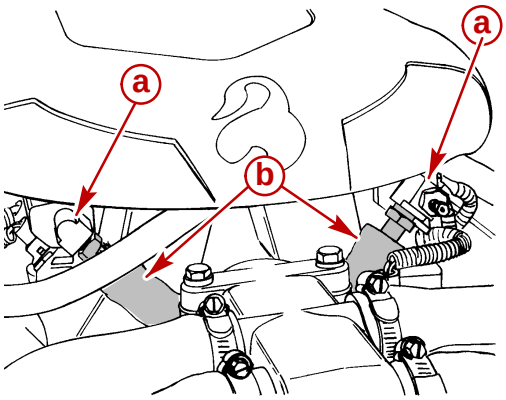


75696

Fuel Lines and Connections - Aft View

a - Fuel Rail Connector Fittings
b - Rail-to-Rail Fuel Lines
c - Cool Fuel-to-Fuel Rail Line
d - Distributor Cap

3. Disconnect fuel lines from front end of fuel rail connector fittings.



75697

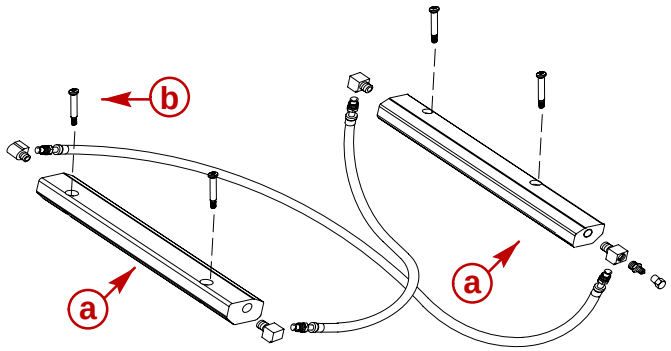
Fuel Lines and Connections - Front View

a - Fuel Rail Connector Fittings
b - Rail-to-Rail Fuel Lines

4. Remove plenum.
5. Disconnect harness connector from each injector.
6. Remove fuel rail screws.
7. Gently move rail back and forth while lifting rail upward.

INDEX

8. Remove fuel rails.



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Typical

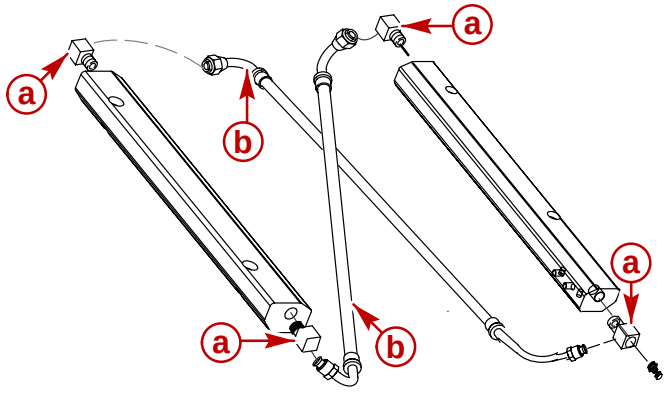
a - Fuel Rails
b - Screws (2 Each Side)

CLEANING AND INSPECTION

1. Clean fuel rails in solvent and dry with compressed air.
2. Inspect injector cavities for damage that could affect proper sealing of the injectors in the rail.
3. Inspect rails for cracks.

INSTALLATION

1. Position injectors in the fuel rails.
2. Install fuel rail by pushing down gently while moving it back and forth.
3. Install fuel rail fasteners. Torque to 105 lb-in. (12 Nm).
4. Route the rail-to-rail fuel lines as shown. Temporarily hand tighten the lines to the fuel rail connector fittings.
5. Torque the four fuel line connections to 18 lb-ft (24 Nm).



75710

Typical

a - Fuel Rail Connector Fittings
b - Rail-to-Rail Fuel Lines

6. Install the plenum and throttle body.

Fuel Injectors

REMOVAL

NOTE: *Use care in removing fuel injectors to prevent damage to the electrical connector and nozzle.*

IMPORTANT: The fuel injector is an electrical component. DO NOT soak in any liquid cleaner or solvent, as damage may result.

1. Remove flame arrestor, throttle body, plenum and fuel rails.
2. Remove fuel injectors from fuel rail and intake manifold.

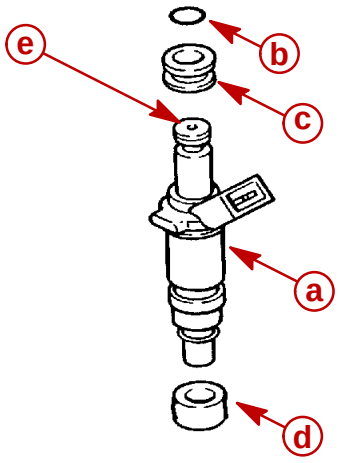
CLEANING AND INSPECTION

1. Inspect fuel injectors for damage; replace if necessary.
2. Inspect screen on inlet side of injector for debris. Clean or replace as necessary.

INSTALLATION

IMPORTANT: When replacing injectors, be certain to replace with the identical part and part number. Other injectors may have the same appearance, yet have a different part number and be calibrated for a different flow rate, and if installed, would cause performance difficulty or damage to the ECM.

1. Install new O-rings on fuel injectors. Lubricate O-rings using a water and soap solution.



72799

a - Fuel Injector
b - O-Ring
c - Upper Seal
d - Lower Seal
e - Screen

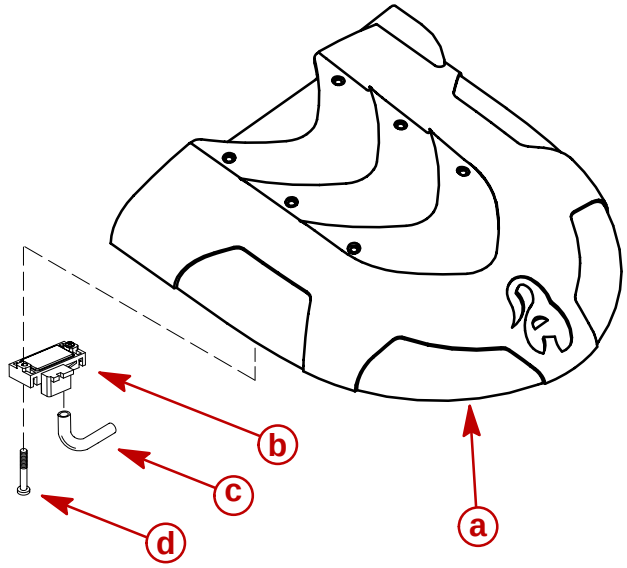
2. Install fuel injectors in the intake manifold.
3. Install fuel rails.

INDEX

MAP Sensor

REMOVAL

1. Disconnect electrical connector at manifold absolute pressure (MAP) sensor.



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a - Plenum
b - Manifold Absolute Pressure (MAP) Sensor
c - Vacuum Hose To Intake Manifold
d - Screws (2)

2. Remove MAP sensor.

CLEANING AND INSPECTION

1. Clean off any foreign matter with a dry cloth.
2. Inspect for any obvious signs of physical damage to the sensor.

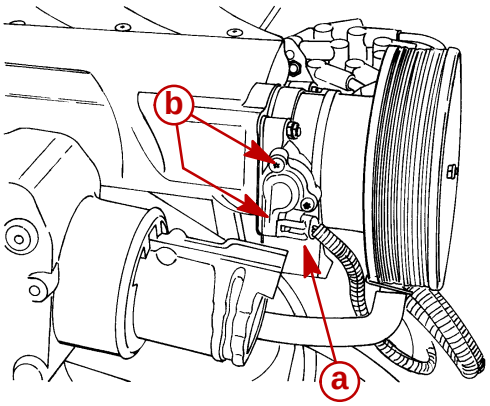
INSTALLATION

1. Install MAP sensor using screws. Torque screws to 44-62 lb-in. (5-7 Nm).
2. Connect electrical connector to MAP sensor.
3. Connect vacuum hose to intake manifold fitting.

Throttle Position Sensor

REMOVAL

1. Disconnect electrical connector at throttle position (TP) sensor.
2. Remove TP sensor from throttle body. Remove the dust seal.



75777

a - Throttle Position (TP) Sensor Harness
b - Screws

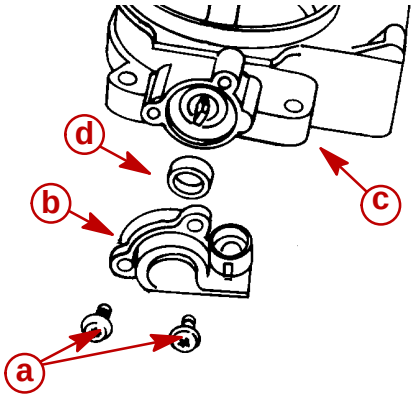
CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the TP sensor for signs of wear or damage.

INSTALLATION

IMPORTANT: If the TP sensor is to be replaced with a new unit, be sure to secure it in place with the new screws which are included in the service package.

1. Install TP sensor and gasket on throttle body using screws with washers and Loctite 242 applied to threads. Torque screws to 20 lb-in. (2 Nm).



75785

a - Screws
b - Throttle Position (TP) Sensor
c - Throttle Body
d - Seal

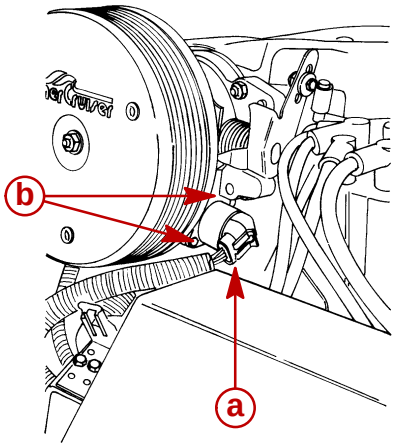
2. Connect electrical connector to TP sensor.
3. Install throttle body, throttle linkage and flame arrestor.
4. Start engine and check for TP sensor output voltage. It should be approximately .7 V at idle and 4.5 V at WOT.

INDEX

Idle Air Control (IAC) Valve

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body.
2. Disconnect electrical connector at idle air control (IAC) valve.



75788

a - Idle Air Control (IAC) Valve Connector
b - Screws

3. Remove IAC from throttle body.

CLEANING AND INSPECTION

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

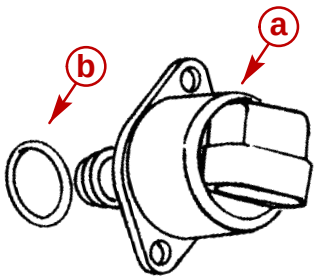
NOTE: *Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.*

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with the correct IAC valve pintle shape and diameter are designed for the specific application.

1. Install new O-ring on IAC valve.

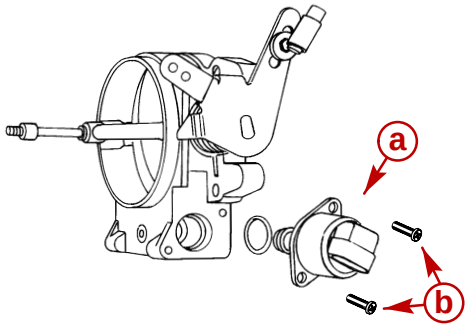


75784

a - Idle Air Control (IAC) Valve
b - O-Ring

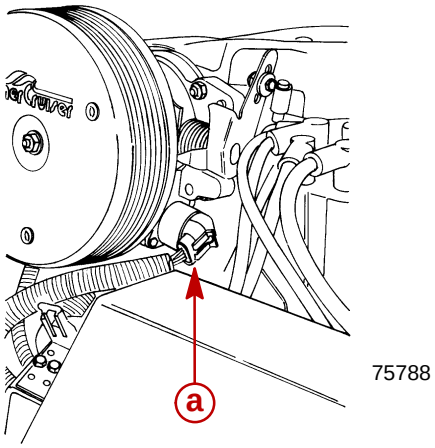
INDEX

2. Install IAC valve on throttle body using screws. Torque to 20 lb-in. (2 Nm).



a - Idle Air Control (IAC) Valve
b - Screws

3. Connect electrical connector to IAC valve.



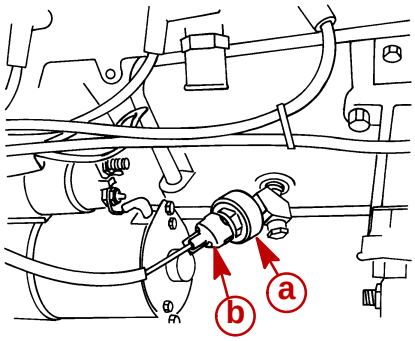
a - Idle Air Control (IAC) Valve Connector

4. Reset IAC valve pintle position after reconnecting negative (–) battery cable.
   a. Turn ignition key ON for ten seconds.
   b. Turn ignition key OFF for ten seconds.
   c. Restart engine and check for proper idle operation.

Knock Sensor

REMOVAL

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



73757

a - Knock Sensor
b - Harness Connector

2. Remove knock sensor from engine block.

CLEANING AND INSPECTION

1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

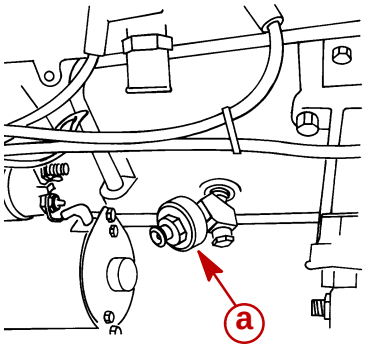
INSTALLATION

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. DO NOT use sealer on threads.

IMPORTANT: Ensure that the knock sensor is installed in the upper location on the Y-fitting.

1. Install knock sensor in engine block. Torque to 14 lb-ft (19 Nm).



73756

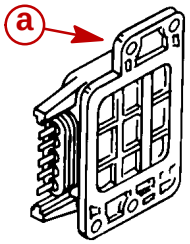
a - Knock Sensor

2. Connect electrical connector to knock sensor.

Knock Sensor Module

REMOVAL

1. Remove knock sensor module (KS) from electrical box.



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a - Knock Sensor (KS) Module

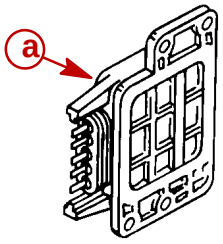
2. Disconnect electrical connector at knock sensor module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

INSTALLATION

1. Connect electrical connector to the knock sensor module.
2. Place KS module in electrical box.



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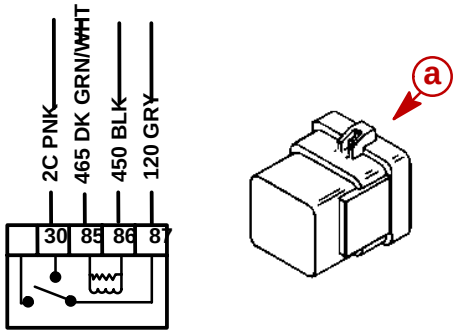
a - Knock Sensor (KS) Module

Fuel Pump Relay

REMOVAL

1. Remove fuel pump relay from electrical box.



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a - Fuel Pump Relay

2. Disconnect electrical connector and remove fuel pump relay.

IMPORTANT: The fuel pump relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

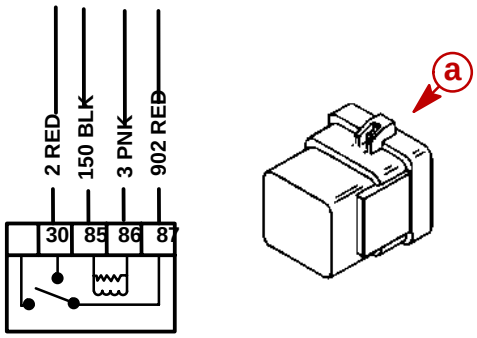
INSTALLATION

1. Attach electrical connector to fuel pump relay.
2. Place fuel pump relay in electrical box.

System Relay

REMOVAL

1. Remove system relay from electrical box.



00000

a - System Relay

2. Disconnect electrical connector and remove relay.

IMPORTANT: The system relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

INSTALLATION

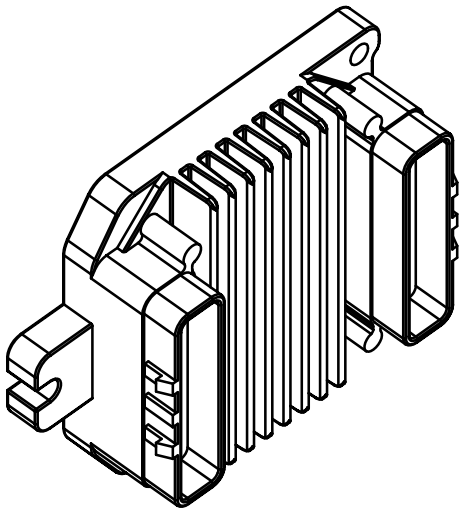
1. Attach electrical connector to relay.
2. Place system relay in electrical box.

Engine Control Module

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Therefore, take care not to touch connector pins when removing or installing the module.

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM).



76358

2. Remove ECM from electrical box.

CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed of the harness.

NOTE: *The ECM is a sealed electrical component. If a Code 51 check has shown it to be defective, replace the unit with another ECM having the same part number as the original.*

INSTALLATION

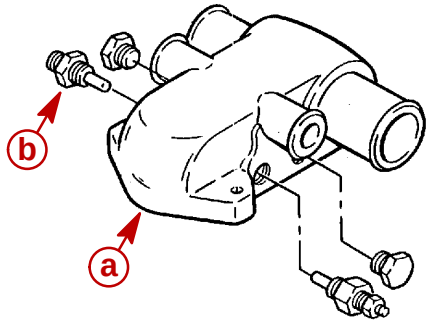
1. Mount new ECM to electrical bracket using screws and washers.
2. Connect J1 and J2 electrical connectors to the ECM. DO NOT touch connector pins when installing.

Engine Coolant Temperature Sensor

REMOVAL

NOTE: *Handle the ECT sensor carefully. Damage to it will affect operation of the system.*

1. Disconnect electrical connector at Engine Coolant Temperature (ECT) sensor.



72799

a - Thermostat Housing
b - Engine Coolant Temperature (ECT) Sensor

2. Remove ECT sensor from thermostat housing.

CLEANING AND INSPECTION

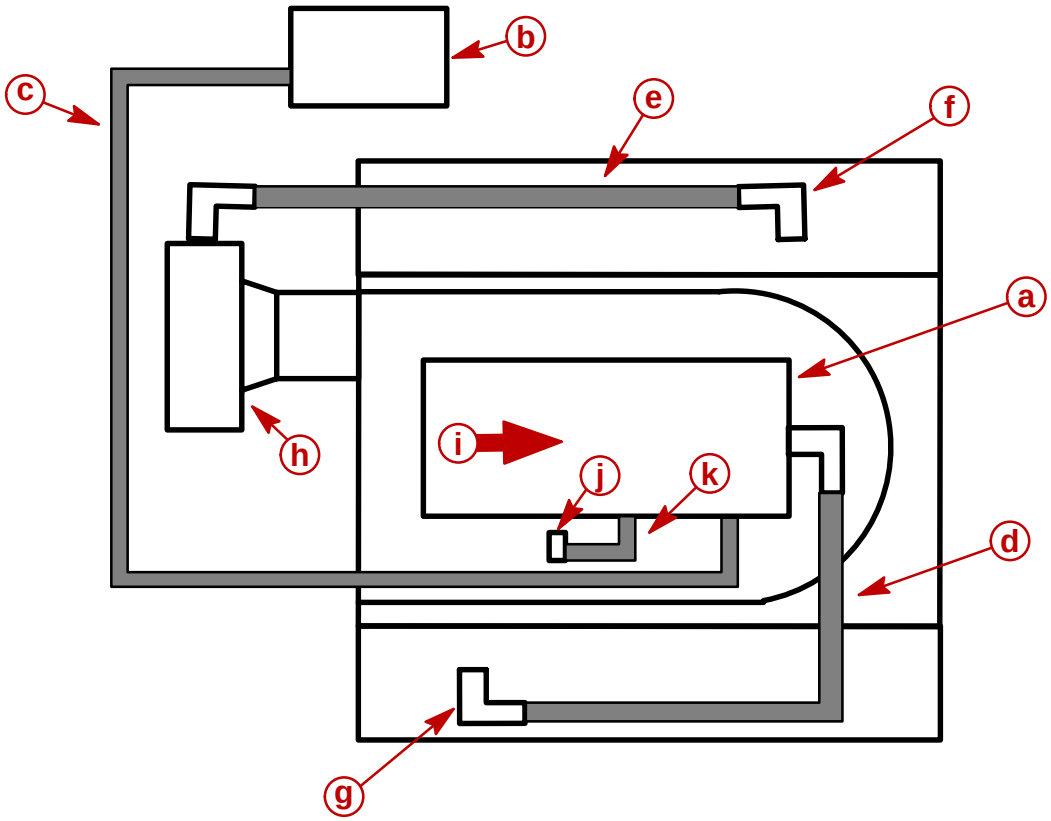
1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT sensor.

INSTALLATION

1. Install ECT sensor in thermostat housing. Tighten hand tight plus 2-1/2 turns maximum.
2. Connect electrical connector to ECT sensor.

Vacuum And Vent Hose Routing

MX 6.2 Black Scorpion Models



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a - Throttle Body
b - Cool Fuel Assembly
c - Vacuum Hose - Forward Fitting On Intake Manifold To Fuel Pressure Regulator on Cool Fuel Assembly
d - Vent Hose - PCV Valve to Throttle Body
e - Vent Hose - Valve Cover to Flame Arrestor
f - PCV Valve
g - Vent Hose Fitting
h - Flame Arrestor
i - Front of Engine
j - MAP Sensor
k - Vacuum Hose - Rear Fitting On Intake Manifold To MAP Sensor

INDEX

FUEL SYSTEMS

Section 5G - Diagnostics

Table of Contents

Special Tools 5G-2
Special Tools (cont'd) 5G-3
Diagnostic Circuit Check 5G-4
Scan Tool Normal Specifications (Idle/Warm Engine/Closed Throttle/Neutral) 5G-4
Diagnostic Trouble Codes 5G-5
ECM Connector and EFI Symptoms Chart 5G-6
J-1 Circuits 5G-7
J-1 Circuits (Continued) 5G-8
J-2 Circuits 5G-9
J-2 Circuits(Continued) 5G-10
Wiring System Diagrams 5G-11
(Continued) 5G-12
With Mercury Distributor 5G-13
With GM EST Distributor 5G-14

5 G

Special Tools

Part Number	Tool Name	Description
J-34029-A (Note 1 and 2)	High Impedance Multimeter (DVM)	Minimum 10 megohm input impedance required on all voltage ranges. As ammeter, accurately measures low value current flow. As ohmmeter, reads 0-200 ohms, 2/20/200 kΩ, 2/20 mΩ
J-23738	Vacuum Pump with Gauge - 20 In. Hg Minimum	Gauge monitors manifold engine vacuum. Hand pump used to check fuel pressure regulator
J-34142-B (Note 3)	Unpowered Test Light	Used to check circuit wiring, short to ground, or voltage.
J-34730-2A	Injector Harness Test Light	Visually indicates injector electrical impulses from the ECM.
J-35616	Harness Test Adapter	Allows multi-meter connections with wiring harness.
94050m	MerCruiser Scan Tool Version 3.4 (English)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Allows for test firing injectors. Tool can read MEFI 1, MEFI 2 and MEFI 3 ECM.
94008	Code Mate Tester	Flashes light to display problem codes
91-99379	Timing Light	Used to check ignition timing. Must have inductive signal pickup.
91-16850A5	Fuel Pressure Gauge Kit	Used to check fuel system pressure. Kit includes 91–803135 Test Port Adaptor Kit and 91–806901 TBI Pressure Valve
91-823686A2	Quicksilver Digital Diagnostic Terminal (DDT)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
91-803999	MerCruiser DDT Cartridge Version 2	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Tool can read MEFI 1, MEFI 2 and MEFI 3 ECM.
84-822560A2	DDT Adaptor Harness	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
91-805747A2	EFI Timing Tool	Used to set Ignition timing. Plug connects to DLC

Special Tools (cont'd)

NOTE: *[1] The High Impedance Multimeter that comes with the existing Outboard 2 Cycle EFI Tester, P/N 91–11001A2 meets the requirements listed above.*

NOTE: *[2] Quicksilver Digital Tachometer / Multi–Meter (DMT 2000) P/N 91–854009A1, meets the requirements listed above.*

NOTE: *[3] Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.*

Kent-Moore Tools, Inc.
29784 Little Mack
Roseville, MI 48066
Phone: 800-345-2233

Rinda Technologies
4563 N. Elston Ave.
Chicago, IL 60630
Phone: 773-736-6633
Fax: 773–736–2950
E–mail: rinda@mcs.net

Diagnostic Circuit Check

IMPORTANT: All references to Scan Tool work with either the Quicksilver Digital Diagnostic Tool or the Rinda Scan Tool.

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an electronic engine control system malfunction.

NOTE: *A scan tool that displays faulty data should not be used. This could result in misdiagnosis and unnecessary parts replacement.*

The scan tool data listed in the following table may be used for comparison after finding the on-board diagnostics functioning properly and no trouble codes displayed. The “Typical Data Values” are intended to represent what a normally functioning system would display.

Only the parameters listed in the scan position column below are used in this manual. If a scan reads other parameters, the values are not recommended for use in diagnosing. If all values are within the range illustrated, refer to “Troubleshooting.”

Scan Tool Normal Specifications (Idle/Warm Engine/Closed Throttle/Neutral)

Scan Position	Units Displayed	Typical Data Value
rpm	rpm	600-700 rpm
Desired rpm	rpm	600 or 650 rpm (Depends on Model[2)]
Coolant Temp.	° F(° C)	150-170° F (66-77° C)
Manifold Air Temp.	° F (° C)	Varies with Ambient Temperature
Throttle Position	Volts	.4 to .8 Volts
Throttle Angle	0-100 %	0-1%
MAP	Volts or kPa	1-3 Volts or (45-55 kPa) (Depends on Vacuum and Baro Pressure)
Baro	Volts or kPa	3-5 Volts (Depends on Altitude and Barometric Pressure)
Bat	Volts	12.0-14.5 Volts
Spark Advance	Degrees	-10 to 30°
Knock Retard	Degrees	0°
Idle Air Control IAC	Counts (Steps)	0-40 Counts
Minimum IAC Position	Counts (Steps)	0-40 Counts
Idle Air Control Follower	Counts (Steps)	0 Counts
Injector Pulse Width	msec.	2-3 msec.
Injector On Time Cranking	msec.	2.5–3.5 msec. (Depends on Water/ Air Temperature)
Fuel Consumption	GPH (L/h)	1-2 GPH(3.7-7.5 L/h)
Time From Start	0:00:00-1092:00	Varies
Memory Calibration Check Sum	Calibration Check Sum	Varies with Software revision in ECM
Oil Press/IO Level[1]	OK/LO	OK
Engine Overtemp	OK/Overheating	OK
Lanyard Stop Mode	OFF/ON	OFF

[1]: MCM will read I/O Level and MIE will read Trans.

[2] : Refer to “Engine and Tune-Up Specifications.”

INDEX

Diagnostic Trouble Codes

Code Number	Code Description
Code 14	(ECT) Engine Coolant Temperature - Low Temperature Indicated
Code 15	(ECT) Engine Coolant Temperature - High Temperature Indicated
Code 21	(TP) Throttle Position Sensor - Signal Voltage High
Code 22	(TP) Throttle Position Sensor - Signal Voltage Low
Code 23	(MAT) Manifold Air Temperature - Low Temperature Indicated
Code 25	(MAT) Manifold Air Temperature - High Temperature Indicated
Code 33	(MAP) Manifold Absolute Pressure - Signal Voltage High
Code 34	(MAP) Manifold Absolute Pressure - Signal Voltage Low
Code 41	(IC) Ignition Control - Open IC Circuit
Code 42	(IC) Ignition Control - Grounded IC Circuit, Open or Grounded Bypass
Code 43	(KS) Knock Sensor - Continuous Knock Detected
Code 44	(KS) Knock Sensor - No Knock Detected
Code 45	Coil Driver
Code 51	(ECM) Calibration Memory Failure
Code 61	Fuel Pressure High
Code 62	Fuel Pressure Low

ECM Connector and EFI Symptoms Chart

The following charts will aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system intact and operational. These are voltage requirements to operate the different circuits.

⚠ CAUTION

Do not attempt to obtain these voltages by probing wires and connectors. Serious damage could result in loss of engine operation or wiring damage. Voltages can vary with battery conditions.

In the following J-1 and J-2 Circuit/Symptom Charts only those pins which are used by the ECM are shown. Pin numbers not listed are not used.

NOTE: *All pins are not used on all models.*

IMPORTANT: The following conditions must be met before testing.

1. Engine at operating temperature.
2. Ignition on or engine running.
3. Scan tool not connected.

THESE NOTES APPLY TO FOLLOWING ECM CONNECTOR AND SYMPTOM CHARTS. The “B+” Symbol indicates a system voltage (battery).

NOTE: *[1] Battery voltage for first two seconds, then 0 volts.*

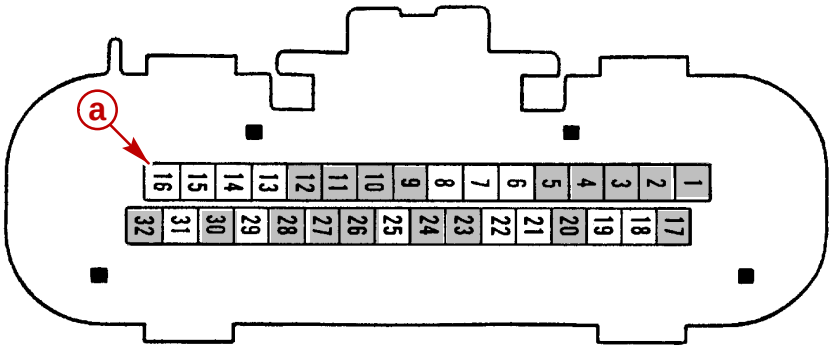
NOTE: *[2] Varies with temperature.*

NOTE: *[3] Varies with manifold vacuum.*

NOTE: *[4] Varies with throttle movement.*

NOTE: *[5] Less than .5 volt (500 mV).*

J-1 Circuits



J-1 Front Pin 32 Pin Input Connector

a - Shaded Area Denotes Pin Connector Location Used On Terminal

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J1-1	Injector Driver	467	DK BLU	B+	B+	None	Rough Idle, Lack Of Power, Stalling
J1-2	Ignition Coil	121	WHT	Not Usable	Not Usable	45	Rough Running, Poor Idle, Lack of Performance
J1-3	Ignition Control Ref. Low	453	RED/ BLK	0 (NOTE 5)	0 (NOTE 5)	None	Poor Performance
J1-4	ECM Ground	450	BLK	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-5	ECM Ground	450	BLK	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-9	MIL Lamp	419	BRN/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Lamp Inoperative
J1-10	Ignition Control Signal	423	WHT	0 (NOTE 5)	1.2V	42	Stall, Will Restart In Bypass Mode, Lack Of Power
J1-11	IAC “B” Low	443	GRN/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-12	IAC “A” Low	442	BLU/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-17	Injector Driver	468	DK GRN	B+	B+	None	Rough Idle, Lack Of Power, Stall
J1-20	ECM Ground	450	BLK	0 (NOTE 5)	0 (NOTE 5)	None	Rough Running, Poor Idle, Lack Of Performance

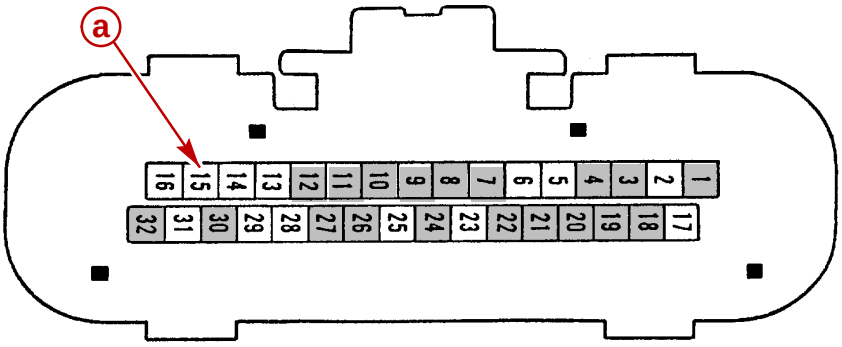
See Page 5G-6 For NOTES

J-1 Circuits (Continued)

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J1-23	Fuel Pump Relay Driver	465	DK GRN/ WHT	0 (NOTES 1&5)	B+	None	No Start
J1-24	Ignition Control Bypass	424	TAN/ BLK	0 (NOTE 5)	4.5V	42	Lack Of Power, Fixed Timing
J1-26	Audio Warning Horn	29	DK GRN	–	–	None	–
J1-27	IAC “B” Low	444	GRN/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-28	IAC “A” High	441	BLU/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-30	Knock Sensor Signal	496	BLU	–	–	43, 44	Poor Fuel Economy, Poor Performance Detonation
J1-32	Serial Data	461	ORN	5V	5V	None	No Serial Data

See Page 5G-6 For NOTES

J-2 Circuits



J-2 Rear 32 Pin Output Connector

a - Shaded Area Denotes Pin Connector Location Used On Terminal

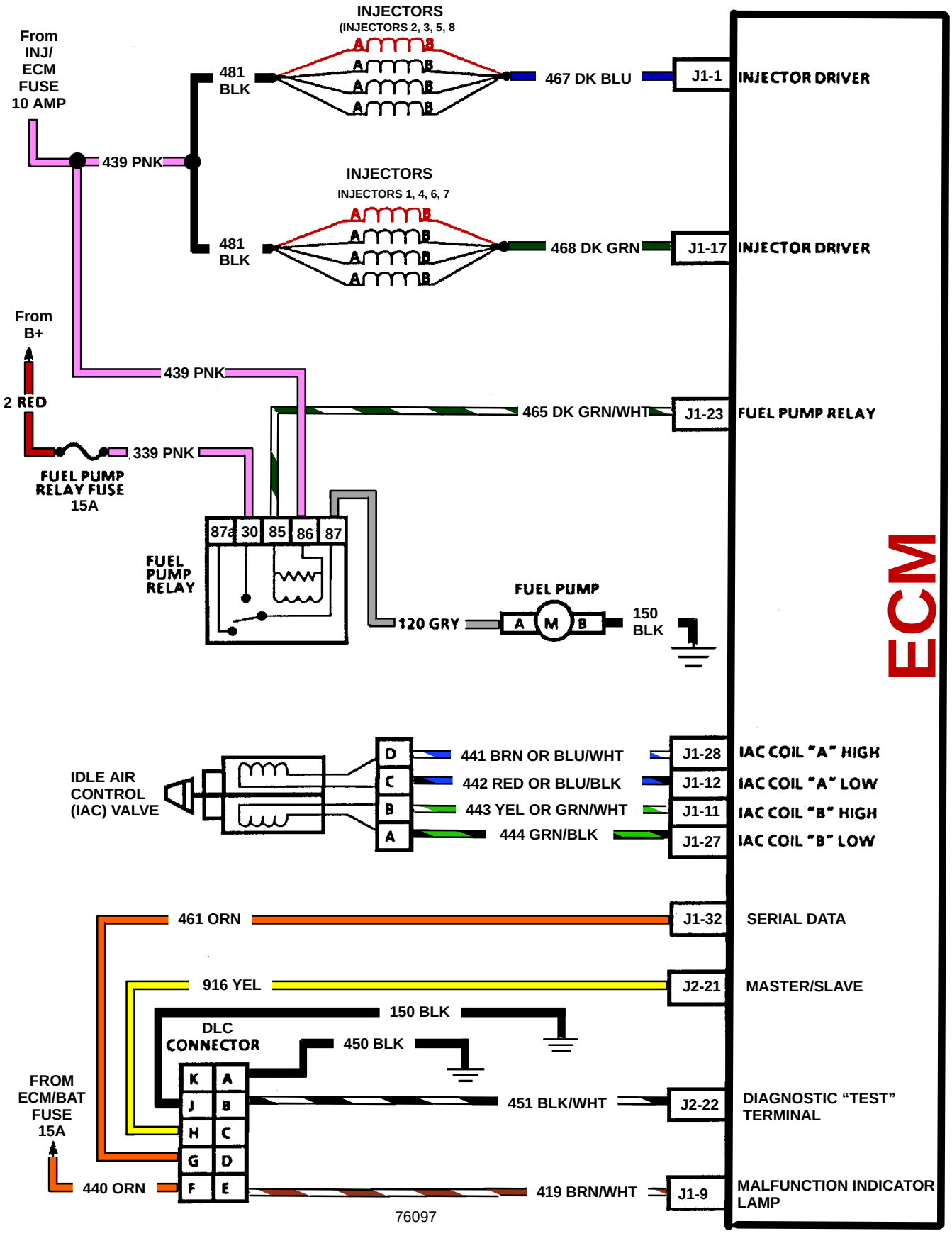
Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J2-1	Battery	440	ORN	B+	B+	None	No Start
J2-3	Sensor Ground	813	BLK	0 (NOTE 5)	0 (NOTE 5)	21, 23	High Idle, Rough Idle, Poor Performance Exhaust Odor
J2-4	TP 5V Power	416	GRY	5V	5V	21	Lack Of Power, Idle High
J2-7	Discrete Switch	114	BLU	–	–	None	–
J2-8	Discrete Switch	585	TAN/WHT	–	–	None	–
J2-9	Shift Switch	923	WHT	0	0	None	Incorrect Idle
J2-10	Ignition Control Ref. High	430	PUR/WHT	5V	1.6V	None	No Restart
J2-11	ECT Signal	410	YEL	1.95V (NOTE 2)	1.95V (NOTE 2)	14	Poor Performance, Exhaust Odor, Rough Idle rpm Reduction
J2-12	Fuel Pressure	475	GRN	3V	3V	61, 62	–
J2-18	MAP Ground	814	BLK	0 (NOTE 5)	0 (NOTE 5)	33	Lack Of Performance,Exhaust Odor, Stall
J2-19	MAP 5V Reference	416	GRY	5V	5V	33	Lack Of Power, Surge, Rough Idle, Exhaust Odor
J2-20	Discrete Switch	208	BRN	–	–	–	–

J-2 Circuits(Continued)

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J2-21	Master/ Slave	916	YEL	B+	B+	None	Lack Of Data From Other Engine (Dual Engine Only)
J2-22	Diagnostic Test	451	BLK/ WHT	B+	B+	None	Incorrect Idle, Poor Performance
J2-24	Discrete Switch	906	TAN/ WHT	–	–	None	
J2-26	TP Signal	417	DK BLU	.62V (NOTE 4)	.62V (NOTE 4)	21	Poor Performance And Acceleration, Incorrect Idle
J2-27	Map Signal	432	LT GRN	4.9V	1.46V (NOTE 3)	33	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J2-30	IAT Sensor	472	TAN	5V	(NOTE 2)	23	Poor Fuel Economy, Exhaust Odor
J2-32	Ignition Fused	439	PNK	B+	B+	None	No Start

See Page 5G-6 For NOTES

Wiring System Diagrams



76097

INDEX

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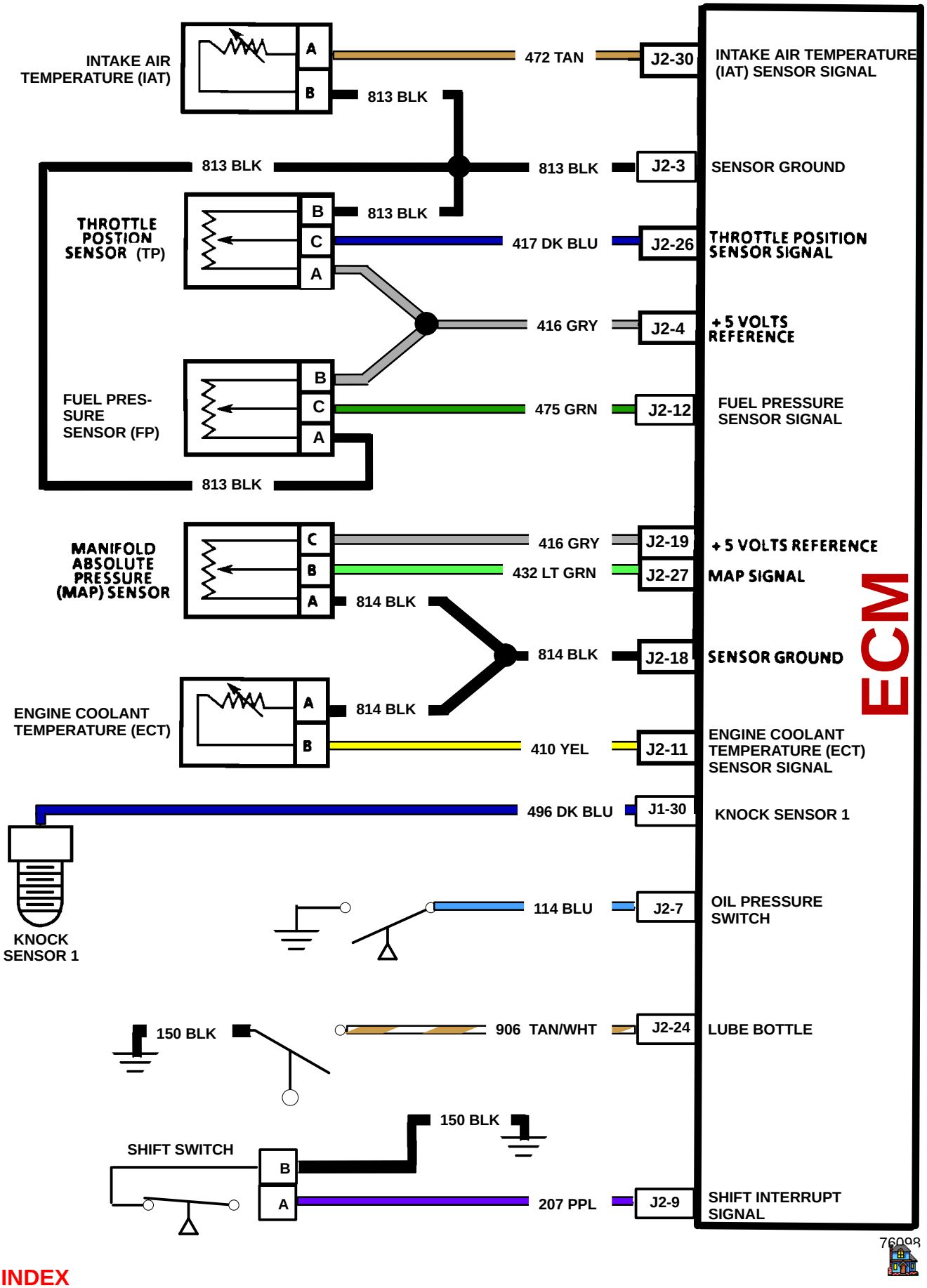
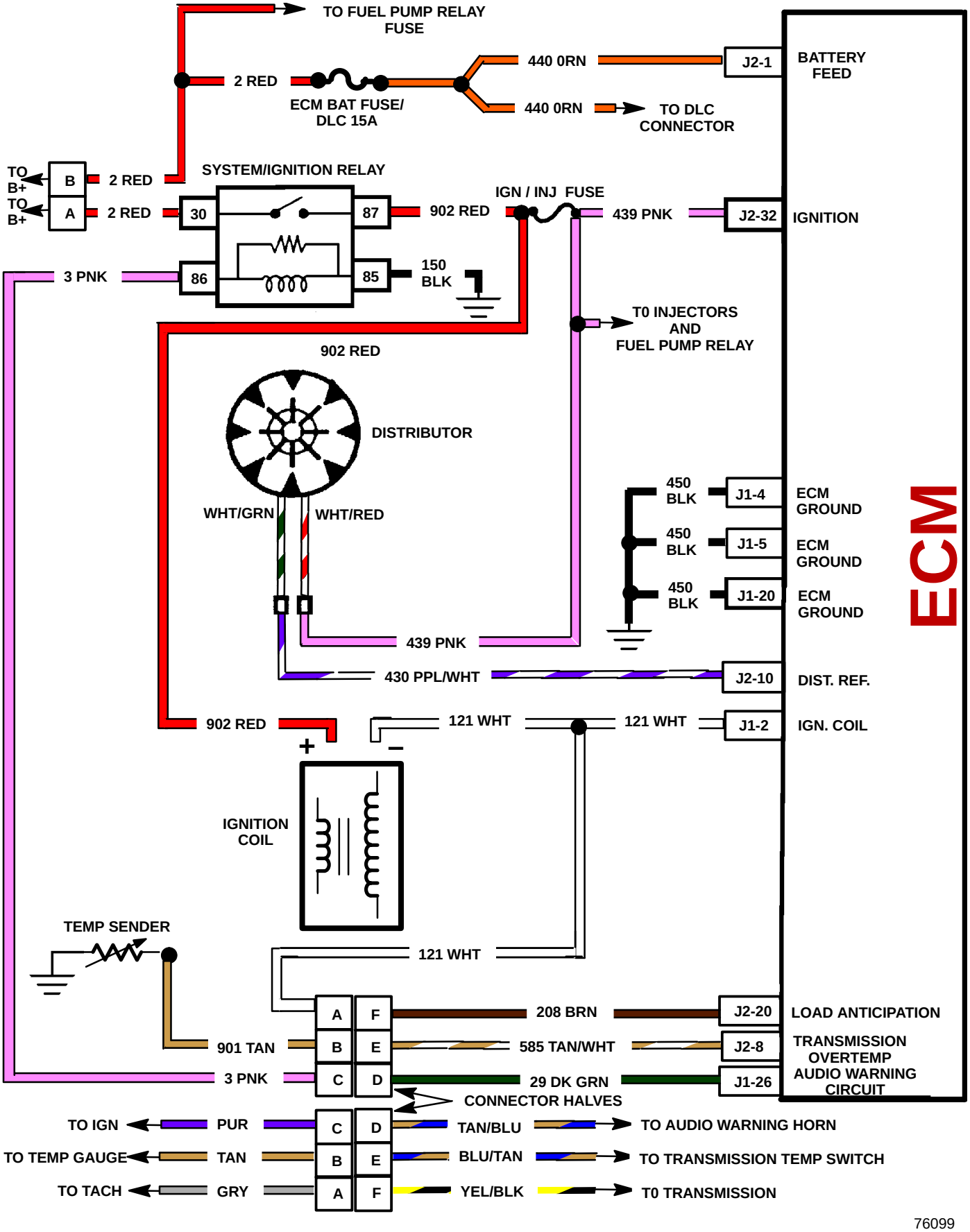


INDEX

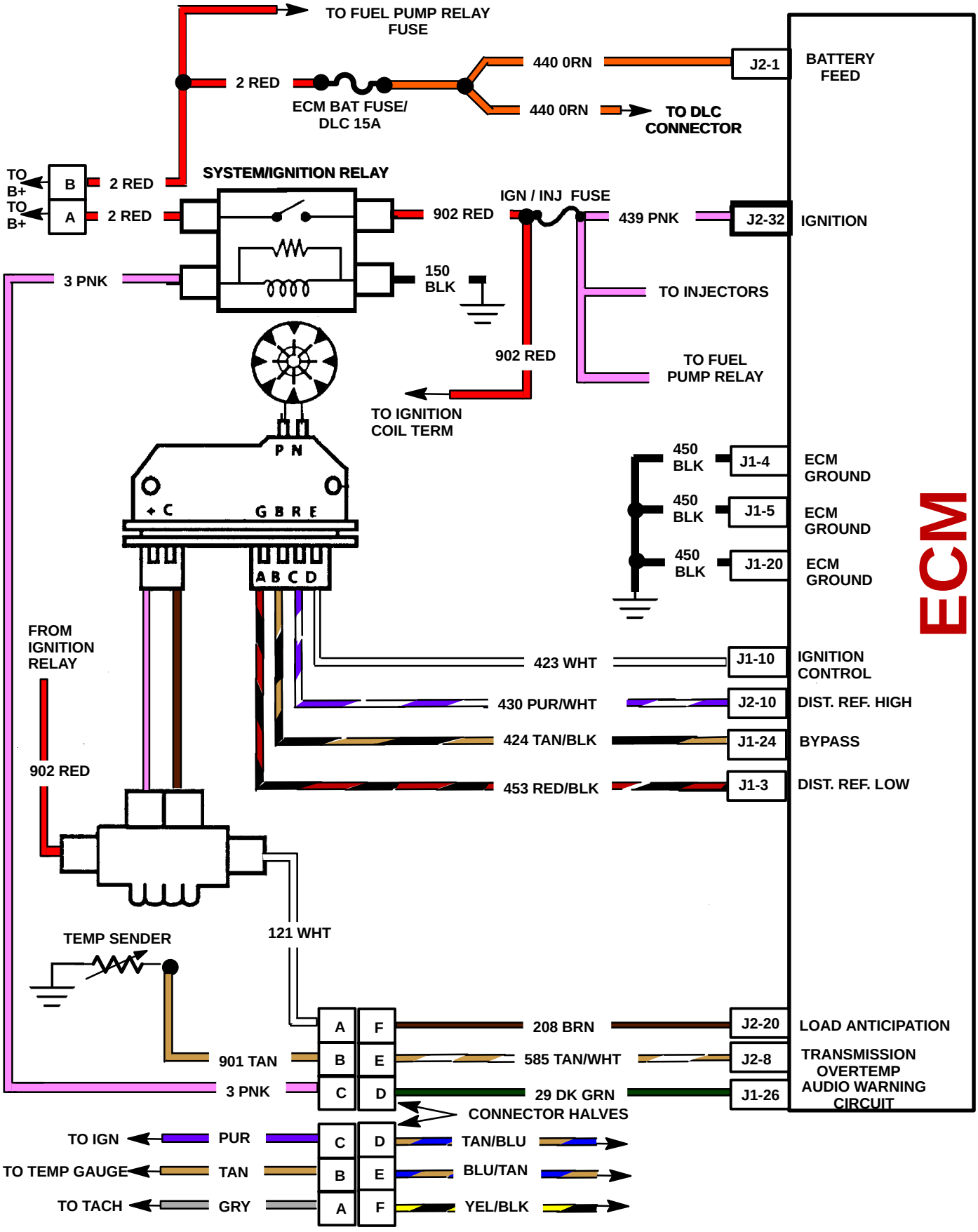
With Mercury Distributor



76099

INDEX

With GM EST Distributor



76099

INDEX